AN AGENCY THEORY OF PATENT LAW:

LINKING INNOVATORS AND INVENTION USERS

by

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ABSTRACT

This article presents a reinterpretation of patent laws as shapers of agency relationships between innovators and innovation users.[1] Patent rights reflect latent incentives encouraging potential innovators to understand, analyze, and solve the practical problems of innovation users. In this way, patent rights link and align the interests of innovators and innovation users. They make innovators specialized agents of innovation users in the pursuit of technologically distinctive and patentable innovations.

By presenting the promise of rewards for serving the interests of innovation users, patent rights both attract the attention of technology specialists to the solution of practical problems they might otherwise overlook and press these specialists to explore the boundaries of their technical fields to propose outlier solutions that will meet patent law tests for intellectual property rights. The results are both more attempts at technical solutions and more breadth in the content of those solutions. In these ways, patent rights serve fundamental roles in incentivizing technical advances and improving the useful arts, all without the transaction costs of contract formation efforts typically underlying agency processes. Patent rights are, in short, the linchpins to an ongoing system inviting and luring technical specialists to

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1 The term "agency relationship" is used here in a behavioral sense, not as a reference to a legally recognized "agency" as defined by "agency law." Agency law primarily defines the powers and liabilities created when two persons enter into an agreement that one of them (the agent) will act on behalf of the other (the principal). By contrast, the term "agency relationship" is used here to refer to the conduct of one person seeking to promote the interests of another regardless of whether this course of action results from a formal contract or from other structured motivations such as the promise of valuable patent rights upon the completion of certain successful innovation efforts.

serve as agents of innovation users, with the acceptance of the ongoing invitations manifested by successful completion and commercialization of widely useful inventions.

I. Introduction

This article describes how patents serve as substitutes for privately negotiated contract terms in defining incentives for potential innovators with specialized technical knowledge or practical experience and linking the interests of those innovators to the interests of potential innovation users. Patents not only align the interest of these parties by giving innovators a potential stake in solving the practical problems of innovation users, they serve to align and scale the concerns and resource allocation of inventors to the scope and depth of demand for inventions by potential users. The rewards available through patent rights incentivize inventors to look to the needs of invention users for definitions of useful advances. The size of these rewards are scaled (at least roughly) to the degree of utility achieved for invention users via successful invention projects, meaning that big rewards attach to highly useful (or at least popular) technical solutions and lesser rewards to less useful advances. This, in turn, encourages attention to projects and the use of research resources in proportion to the utility of solutions being pursued. In both attracting the efforts of innovators and signaling the importance of innovation projects, patent rights encourage inventors to act as agents of invention users in efficient ways. And the formation of these agency relations is achieved without the need for innovation users to identify and form agency contracts with potential innovators. Consequently, patents overcome many of the informational and transactional limitations of private agency contracts as means to encourage innovation progress.

The agency-focused interpretation of patent law advocated here has several advantages as a means to understand the impacts of present patent laws and to project needed reforms. First, it emphasizes the technology-enhancing goals of patent laws over sometimes misleading considerations of property rights and controls.[2] Patent law standards are desirable under this model solely if they promote the interests of principals in acquiring new technologies. Rights and incentives provided to innovators are viewed as instrumental means to promote the interests of innovation users and consumers who occupy the position of principals in the patent-structured relationships of interest.

Second, by viewing innovation efforts as agency processes and assessing patent rights as one feature shaping these agency processes, previously developed methodologies for analyzing agency processes can be applied to patent-mediated innovation processes, leading to expanded descriptive and normative studies of the patent system. Descriptive studies employing an agency model can help us assess the probable impact of present patent standards in promoting innovations of benefit to invention users. Normative studies using this model can suggest how patent incentives should be adjusted to bring innovative efforts serving invention users to more efficient levels.

Third, by viewing patent rights as tools for shaping agency relationships promoting innovation we can gain new insights about situations where patent rights should and should not apply. The likely

[2] The model proposed here recognizes that property controls over innovations may provide means to reward innovators for the successful pursuit of the interests of user-principals in innovative agency relationships. Property rights concerning patented inventions are treated in this model as a form of compensation awarded to innovators who have met their part of the innovation bargain implicit in patent laws by diagnosing and solving some practical problem of potential invention users. The key questions governing the proper scope of patent rights within this model are what sorts of rights will properly align the interests of innovation developers and users and under what circumstances should the property rights flowing from the issuance of a patent be recognized under our legal system?

success of innovation-focused agency processes dictates the appropriate boundaries of the patent system under this approach. In settings where agency processes are unlikely to be effective in promoting useful innovation, associated patent rights will also serve no useful role and may imposed wasteful costs or restrictions on business activities. Seen this way, the scope of potentially effective agency processes for innovation helps to delineate the proper boundaries of the patent system and provides a new means to study the proper scope of patentable subject matter.

The analyses in this article proceed in five parts. Section II describes the proposed agency model of patent rights in which patents are components of broader patent-mediated agency processes for technological innovation. The model is developed by initially considering the agency features of innovation projects involving one innovator working on behalf of one potential innovation user. This version of innovation involves a single principal (the potential innovation user) and a single agent (the innovator). Many of the agency features present in this simple project are also present in larger, multi-agent projects but can be studied more effectively and clearly in the simpler type of project. Moving from this simple case, I then examine extensions of the model along two dimensions. One extension considers the agency implications of including multiple potential innovators as competing parties seeking to produce an advance for a single potential user. This extension involves a single principal (the potential invention user) working with multiple agents (the competing innovators). The second extension examines the agency implications of moving from a single potential user to a setting where potential innovation users are numerous and diverse, but nonetheless share a common interest in a particular functional innovation feature that makes the group of users a common target of a single innovation project. This type of innovation involves multiple principals (comprised of the members of the user group) being served by multiple agents (the multiple competing innovators).

Part III summarizes agency theory and suggests how it may be applied to interpret patent-mediated agency relationships. Features and limitations of patent incentives as means for shaping and administering innovation-focused agency processes are also explored.

Part IV uses the proposed model to identify patent law features that affect the impact of patent rights on innovation-focused agency processes. This discussion will critique a number of present patent law doctrines in terms of whether they successfully align the interests of invention users and innovators and thereby create desirable agency relationships.

Part V considers the outer boundaries of the proposed model and implications of these boundaries regarding the proper scope of patentable subject matter. I argue that patent incentives are only needed to promote agency processes for innovations with substantial user sets where direct contracting processes for encouraging innovation are unlikely to be effective. This will be the case where numerous potential users can benefit from an innovation (through either widespread use or repeated use of the innovation or both) and the innovation can be described and transferred to users in a systematic manner without direct interaction between the innovator and the users of her innovation.

Finally, in Part VI I consider several features of the patent system that may deserve reconsideration in light of their impacts on agency processes for innovation. The breadth of the patent law characteristics considered -- including such diverse patent law features as pre-issuance patent application publication, non-obviousness standards, and rewards to patent applicants in corporate environments -- is indicative of the wide-ranging value of agency theory in critiquing present patent standards and shaping future patent policy.

II. Components of an Agency Theory of Patent Law

The agency theory of patent law described here treats patent rights incentivizing tools to activate actions by technology specialists working as agents on behalf of innovation users. Patent rights will incentivize innovation and support agency relationships between inventors and invention users if those rights function as substitutes for directly negotiated innovation payment terms negotiated between innovators and innovation users. In actual patent-mediated innovation processes, there are no such negotiations. Innovators self-identify themselves as possible inventors and project the potential needs of innovation users. They then act as agents of innovation users by seeking successful inventions despite the fact that no contract or other private arrangement for payment for inventive labor exists between the innovator and the parties who will benefit from innovation efforts if they are successful. The payoffs implied by patent rights provide the substitutes for these missing agency contract terms. They both encourage potential innovators to consider acting as agents for innovation users and establish the mechanism for agency payments once the needs of principals (that is, innovation users) are served by successful inventions.

This section provides a summary of this agency framework for interpreting patent rights.

A. Establishing a Context and Purpose for Patent Rewards

Patent laws and related restrictions on patented inventions are traditionally justified as means to create rewards for inventors that promote socially beneficial innovation.[3] Patents are intended to "promote the Progress of … [the] useful arts" by increasing specialized knowledge about useful items and processes and applying that knowledge to produce more such items and processes[4] Patent rights afford an inventor exclusive control over such commercially significant activities as the making, using, selling, and importing of a patented invention to create exclusive commercial opportunities and gains that reward the inventor for his or her inventive efforts.[5] The scope of the potential rewards varies with the value and popularity of the resulting invention and the willingness of users to pay substantial patent-influenced prices for the invention.

The promise of patent-influenced rewards is aimed at encouraging persons with specialized capabilities or insights to apply their efforts to developing useful innovations. John Stuart Mill captured the essential reward logic underlying patent rights with his observation that an inventor producing a socially valuable advance "ought to be both compensated and rewarded" through the grant of a temporary "exclusive privilege" conveyed by a patent.[6] Mill felt such a patent-based reward scheme was preferable to other innovation incentivizing schemes -- such as government-issued prizes or rewards for useful advances. Patent-influence rewards delivered via commercial transactions and processes were superior in Mill's estimation because such rewards avoided any need for discretionary action by parties authorizing rewards, secured commercial rewards to inventors in amounts varying with the value and usefulness of inventions as seen by users, and ensured that the rewards given inventors were ultimately paid for (via

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3 *See, e.g.*, Mark F. Grady & Jay I. Alexander, *Patent Law and Rent Dissipation*, 78 Va. L. Rev. 305, 310 (1992) (noting the "long intellectual history of reward theory" in justifying patent rights).

4 United States Constitution, Art. I, Sec. 8, Clause 8.

5 *See, e.g.*, Mark F. Grady & Jay I. Alexander, *Patent Law and Rent Dissipation*, 78 Va. L. Rev. 305, 310 (1992).

6 2 John Stuart Mill, Principles of Political Economy 548 (D. Appleton & Co. 1901) (London, 5th ed. 1862).

background processes resulting in patent-elevated invention prices[7]) by the users who benefited from the inventions.[8]

This view provides a framework for thinking about both patent rights and the types of patent rewards that will best serve the aims of the patent system. If patent rights are created and administered to incentivize innovation on behalf of invention users, then these rewards will be justified up to (but not beyond) the point where they attract capable innovators to undertake innovation projects that are cost-effective taking into account their likelihood of success, the social value of the innovations they target, the costs of completion, and the further opportunity costs of the alternative activities by innovators that inventive efforts displace (that is the costs of the foregone activities that innovators cannot complete because they are busy with innovation projects).

Mill's framework treats patents as instrumental means to economize on the time and talents of persons who are capable of producing patentable advances.[9] In order to encourage these persons to allocate their time to work on the most socially beneficial types of advances, it is desirable to link the efforts of potential innovators to the interests and invention gains of innovation users. This linkage will "price" the time of talented individuals in accordance with the scope of public benefits that are likely to result from various innovation efforts.[10] Furthermore, in seeking these important advances, patent rights encourage innovators to give special attention to designs that incorporate previously unproven and "non-obvious" features of the sort needed to qualify for patent protections.[11]

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7 Retail prices charged to users of patent-protected products or services tend to support large rewards to inventors even if the inventors have transferred their rights to the relevant invention to their employer or another commercial entity such that a party other than the inventor is the immediate seller of the patented product. The terms on which transfers of the inventors' rights are accomplished are influenced by the transferee's anticipation of patent-influenced retail sales revenues in the future. Hence, the salary and bonuses given an employee working on patentable advances are influenced by his or her employer's knowledge that resulting patented inventions can be sold at patent-influenced prices in the future. Likewise, the amounts that individual inventors who are patent holders are paid for assignments of their inventions are influenced by the assignee's expectation that the transferred patent will allow the assignee to charge patent-influenced prices for related products or services in the future.

8 *Id.*

9 Under this view, the impact of patents must be judged not in light of how they are enforced, but rather at an earlier point when the promise of enforcement influences the conduct of a potential innovator and others (such as employers and resource providers) who interact with the innovator. The scope of rights upon patent enforcement will bear on what value innovators (or their employers and resource providers) associate with alternative projects as they contemplate directions for innovative efforts. Patents influence choices about these directions. The degree to which they influence these choices will depend in part on the strength of patent rights and the resulting projected value of anticipated patent enforcement patterns.

10 I have explored this innovation behavior pricing and prioritizing logic underlying patent law elsewhere. *See generally* Richard Gruner, *Dispelling the Myth of Patents as Non-Rivalrous Property: Patents as Tools for Allocating Scarce Labor and Resources*, 13 COLUMBIA SCI. & TECH. L. REV. 1 (2012).

11 Patents are limited to useful inventions that are both new and significantly different from prior advances in the same field. *See* 35 U.S.C. § 103. This later requirement – imposed via tests requiring inventions to be "non-obvious" to average practitioners in the relevant field – are applied primarily to disallow patent rewards (and avoid patent system costs) for advances that reflect minor technical adjustments to prior designs in the same field in which the new design is so similar to prior designs (or is made along such familiar lines of previously successful adjustment) as to be predictably successful to many parties in the field. Advances involving such minor adjustments are thought to be within the capabilities of many parties and thus likely to result without the special incentives of patent rewards. By contrast, the sorts of non-

This view of patents solves a long-standing conceptual problem in patent law regarding the policy basis for granting inventors exclusive "property rights" over the use of patented inventions. Such rights are not needed to avoid exhaustion or inefficient consumption of the inventions themselves since these inventions are ideas that cannot be exhausted. But patent rights resembling property rights can be useful means to govern the use (and misuse) of inventors' time and resources, which certainly are exhaustible resources. The potentially scarce time and abilities of talented innovators need to be carefully allocated via properly crafted incentives that both attract these parties to projects of large public interest and prioritize the scope of innovators' efforts among projects of public concern. Patents create and scale the proper incentives by "pricing" the time and resource exhaustion of innovators in accordance with the socially beneficial results they achieve (as mirrored in the commercial value of the patent-protected products they enable).[12] Hence, a property logic underlying patent rights is sensible because property controls over access to patent-protected inventions activate a system economizing on the scarce resources of inventors' time. Property-based patent rights are not justified because inventions are scarce resources but rather because the efforts and resources of the inventors who produce the inventions are scarce. Property-based patent rights are simply part of a labor incentivizing and economizing system influencing innovators via rewards gained from the products of their labor.[13] Patent-influenced controls and rewards

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obvious advances that patents encourage involve previously untried design approaches in the relevant fields which will be rare and worthy of the special encouragement of patent rewards.

[12] Robert Merges has recognized that intellectual property rights can be a means to "propertize" the labor of an innovator and thereby reallocate how that labor is integrated into business enterprises. He has analyzed the implications of intellectual property rights in the context of the work of a consultant:

> A consultant generally can only sell a given unit of labor once, and she can sell it only to a single firm. Intellectual property, however, in effect 'propertizes' her labor, making it possible to sell the same unit of output multiple times to multiple firms. Of course, for this to work, the consultant must produce something that intellectual property law protects, and she must retain ownership of her work product, typically by contract. Assuming ownership of a protected work, however, intellectual property rights allow her to transform her efforts from a onetime service into a multiple-use commodity. This conversion of services into an asset that the producer can trade many times of course enhances the potential economic returns from such work.

Robert P. Merges, *Intellectual Property and the Costs of Commercial Exchange: A Review Essay*, 93 MICH. L. REV. 1570, 1575 (1995). Merges argues that this propertization process will tend to encourage innovators to pursue valuable advances for the advances♠ own sake, with confidence that they can gain commercial returns on the resulting advances through specialized businesses engaged in developing advances and licensing rights to use the advances.

While these insights into the impact of intellectual property rights on specialization and enterprise organization dynamics are important, Merges does not address the further implications of the "propertization" effect of intellectual property rights examined in this article. As described here, the "propertization" of innovative labor achieved by attaching patent rights and associated rewards to the production of patentable inventions may aid in economizing the allocation of labor and other resources within a business or within the work choices of an individual and, hence, encourage the allocation of additional innovative efforts towards activities and advances of significant social value.

[13] Actually, the view of intellectual property rights advocated here focuses on property controls of innovators over the fruits of their labors rather than over the labors themselves, with the controls over the products of labors influencing what labors are undertaken in the first place. Robert Merges has noted this distinction in a somewhat different context, giving the following explaining his views of the "propertization" of labors of creative persons through associated intellectual property rights:

ensure that the scarce resources of talented innovators (and the also scarce resources of money and equipment dedicated to innovation by companies[14] or other organizations such as major universities that support large-scale innovation) are not misallocated.[15] Patents are instrumental means of attaching legally-promised rewards and payments to choices by innovators to pursue socially beneficial innovation activities.

B. Agency Relationships Resulting from Patent Linkage of Innovators to Invention Users

1. Characterizing Agency Relationships

> Commentators at least since Locke have asserted that everyone owns his or her labor; in Locke's case, this was an outgrowth of his starting point that everyone owns his or her own body. John Locke, Two Treatises of Government 328-29 (Peter Laslett ed., 1960). But when these commentators refer to a property right in one's labor, they are talking about the right to bargain for a wage before engaging in work -- in essence, the right not to be a slave. By contrast, I am referring to the conversion of labor into a tradeable asset or property right. "Assetization" might be a more appropriate term for what I have in mind; but since this sounds even worse than "propertization," I will stick with the latter.

Id. at 1575 n.12.

[14] Corporations, even more than individuals, structure their resource allocations in accordance with the profit potential of various alternative actions. Corporate decision-making processes typically force parties requesting allocations of limited corporate requests to justify their requests in terms of the profit potential associated with their requested use of the resources. In responding to competing resource requests supported by this type of profit potential information, internal corporate resource allocation processes often serve as internal capital markets for the allocation of corporate "investments" of budgets and other corporate resources to projects in light of the projected profit potential of the projects. In these internal capital market systems, potential invention efforts compete for resources with requests for many non-innovative projects that are also potential sources of increased corporate profits (such as additional marketing efforts for old products or additional cost cutting measures). Whichever actions seem likely to produce the greatest corporate profit returns will tend to be seen as the best use of corporate "capital" reflected in available corporate resources and will tend to receive those resources as company managers make commitments to certain projects and reject others. *See* R. Gruner, S. Ghosh, & J. Kesan, TRANSACTIONAL INTELLECTUAL PROPERTY: FROM STARTUPS TO PUBLIC COMPANIES (Lexis/Nexis 2012); George G. Triantis, *Organizations as Internal Capital Markets: The Legal Boundaries of Firms, Collateral, and Trusts in Commercial and Charitable Enterprises,* 117 Harv. L. Rev. 1102, 1105, 1109-15 (2004).

[15] In this regard, patents are not so much about avoiding overconsumption of a resource -- the so called "tragedy of the commons" -- as they are means to avoid an inverse "tragedy of misallocation" that can result where resources are not allocated to their highest use -- that is, the most socially valuable use. The asset that is at risk of misallocation absent patent rights is the labor of those highly skilled individuals who are most likely to produce patentable innovations. Absent patent rights, the labor of these parties may be allocated to tasks other than the sorts of unusual advances with high social value that these individuals (and perhaps only these individuals) are capable of producing. The avoidance of this type of misallocation is, according to Harold Demsetz, one of the primary justifications for recognizing property rights is that, in a world of no transaction costs, such rights will internalize the costs and benefits of an activity in the rights owner. *See* Harold Demsetz, *Toward a Theory of Property Rights*, 57 AM. ECON. REV. PAPERS & PROC. 347, 348, 349 (1967). By attaching property rights in the form of patent rights to certain types of unusual, non-obvious innovations of talented individuals and connecting rewards to the patent rights that are equal to the net social benefits of patented inventions, patent laws can aid innovators in internalizing the positive externalities associated with decisions about whether to pursue innovative activities and thereby improve the quality of those decisions in efficiently allocating the labor of talented individuals.

Agency relationships for innovation are all around us, accounting for many of the innovative products and expert services in our complex society. Agency relationships involve actions taken by one person (the agent) on behalf of or for the benefit of another (the principal).[16] Typically, an agent will receive a reward for successful completion of the tasks desired by a principal so as to align the incentives and interests of the agent with those of the principal. However, flaws in information gathering and other transactional processes may frustrate the implementation of ideal incentives for agents and lead to the imperfect alignment of principal and agent interests. Principals may imperfectly monitor the completion by agents of desired actions, leading to the granting of rewards to agents when no benefits for principals have actually been achieved. Principles may also pay too little or too much to agents for the completion of tasks desired by the principals, thereby causing the agents to devote too little or too much effort to the completion of the tasks given the value of the tasks to the principals. These types of errors lead to significant gaps and inefficiencies in the links between rewards to agents and benefits to principals. Such gaps can cause agents to diverge significantly from the efficient attainment of principals' goals.[17]

These types of agency processes and problems have been the focus of extensive studies by economists and others. Most studies of agency relationships and processes have focused on agency arrangements created in direct transactions between principals and agents resulting in contractual relationships between the parties. The resulting contracts typically define contingent rewards and incentives aimed at encouraging agents to take specific actions serving principals' interests. For example, a typical, contract-based agency relationship arises where a homeowner engages a neighbor's child to mow the homeowner's lawn for $10.00, with payment to occur when the lawn is completely mowed. If all goes well, the child (acting as the agent) will mow the lawn and serve the interests of the homeowner (acting as the principal). The withholding of payment until completion of the mowing both serves to make this promised payment an incentive for diligent work by the child in completing the mowing and also gives that homeowner a chance to monitor the results and check the quality of the agent's efforts before delivering the promised reward (thereby providing some assurance that the reward is not being paid for no effort or flawed efforts). This simple agency transaction incorporates all of the major features of an agency relationship and suggests how commonplace agency relationships are in our everyday activities.

However, economists have recognized that face-to-face transactions leading to contract-based agency relationships are not necessary to create agency incentives and processes. Agency arrangements resulting from contracts are merely a familiar and relatively simple subset of all agency relationships. The full range of agency relationships includes all arrangements in which one party's actions serve the interests of another, usually in response to contingent rewards or penalties encouraging such actions.

Recognizing that agency processes go far beyond contractual relationships, Steven Shavell has described the breadth of agency processes as follows:

> In [agency relationships], one party, the principal, "enjoys" the outcome of the activity of the other party, the agent. The agent's effort (or expenditure or, more generally, his action) together with a random element determines the outcome. The principal then pays the agent a fee. For the case of a professional and his client this description of the principal and agent relationship is obviously appropriate. The description may be seen to apply to [other cases such as the relationship between insurer and insured, shareholders and management, and even society and a

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16 *See generally* K. Eisenhardt, *Agency theory: An assessment and review.* 14 ACADEMY OF MANAGEMENT REVIEW 57, 57-74 (1989).

17 *See id.*

> polluting firm] and, indeed, to any relationship where only one of the parties directly influences the probability distribution of the outcome.[18]

In these settings, the value of the outcome to the principal or the "fee" paid to the agent can be positive or negative. For example, in a principal-agent relationship between society and a polluting firm, both the outcome received by the principal (pollution costs suffered by society) and the "fee" applied to the agent (the costs in fines or other penalties imposed on a polluting firm) are negative.[19] The simplest forms of principal-agent relationship will involve promises of positive payments to an agent for the realization of positive results for a principal (such as the lawn mowing relationship already discussed). However, an entirely parallel – and economically equivalent – form of agency relationship can be structured in which negative consequences are threatened for an agent who produces negative results for a principal. The potential advantages (and flaws) of such a negatively-framed agency relationship are equivalent to those in the positive form of the relationship. For simplicity sake, most of the discussions of agency relationships in this article with address relationships involving positive performance results achieved through positive rewards to agents.

In the innovation situations analyzed here, agency relationships influenced by patent rights encourage innovators to examine the problems and needs of potential innovation users and to design technological solutions that provide practical benefits to those users. In both diagnosing the practical problems of potential invention users and in designing solutions, inventors serve as agents of the users they benefit.

Patent rights (and the commercial opportunities they imply for popular inventions) encourage inventors with special knowledge or abilities to look beyond themselves and their own circumstances and consider how technology might be used to serve others. Inventive efforts frequently produce innovations that benefit users who are very different from the innovators themselves (who, at least in today's complex innovation environments, are often highly trained and specialized masters of narrow areas of knowledge and technology).[20] The promise of rewards based on patent rights supplies innovators acting as agents of the potential users of their advances with important incentives to look to the needs of those users and shapes the focus and scope of their innovation efforts. The promised "payoff" enabled – but not fully

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[18] Steven Shavell, *Risk Sharing and Incentives in the Principal and Agent Relationship*, 10 Bell J. of Econ. 55, 55 (1979).

[19] *See id.*

[20] Of course, an innovator may create an advance to aid him or herself, perhaps because the innovator operates or is part of a business that can use the advance to later advantage. In such circumstances, a party may just keep the advance as a secret within that business rather than share it with competitors in ways that will aid the competitors. In such settings, patent rewards still serve a purpose in enhancing the likelihood that an innovator will disclose and commercialize an advance as an agent of potential further users beyond the innovator.

Furthermore, even where an innovator has some personal motivation to pursue an advance for self-benefit, the perspective-enhancing impacts of potential patent rewards may change the type of innovation the individual pursues. The needs and interests of the bulk of users of the advance may be different (or broader) than those of the original innovator. By looking to the full set of potential users as sources of potential rewards – as patents will tend to promote – an innovator is encouraged to adopt the design perspective and goals of the broader user set and to use the needs of that broader set of users as the measure of a successful invention. Thus, even where an inventor is a potential user of an advance, his or her inventive efforts may be valuably influenced and improved by the perspective-setting agency influences of promised patent rights.

guaranteed – by patent rights is the special "fee" paid to innovators for playing their parts in the patent-mediated principal and agent relationships between invention producers and users.

Within this framework, various substantive and procedural criteria for recognizing and administering patent rights may be better or worse in linking the interests of inventors and invention users and in establishing desirable agency relationships for innovation. A descriptive assessment of present agency characteristics and inefficiencies embedded in patent laws and procedures is contained in Section IV of this article. Using the same agency perspective, a normative evaluation of how patent reforms might improve the operation of innovative agency processes is contained in Section V of this article.

B. A Preliminary Distinction Between Agency Law and Agency Relationships

In the discussions which follow, it will be useful to remember that, despite the similarity of its name, agency law has little to do with the agency relationships considered here.[21] The agency relationships described here are behavioral relationships not relationships defined or regulated by agency law.[22] Agency law primarily addresses agency relationships created in face-to-face transactions, usually involving explicit (albeit sometimes brief) agency contracts between the parties.[23] Agency law supplements the terms of these contracts and describes certain consequences flowing from the formulation of agency arrangements. This body of law is intended 1) to protect the interests of parties affected by agency arrangements who are not parties to the agency contracts and 2) to specify certain default terms defining key agency relationship features where the parties' own agency contracts are incomplete and do not address these key features.[24]

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[21] The most recent draft of the Restatement (Third) of Agency describes the distinction between the behavioral and legal definitions of agency relationships as follows:

> "[T]he terminology of agency is widely used in commercial settings and academic literature to characterize relationships that are not necessarily encompassed by the legal definition of agency. ... In economics, definitions of principal-agent relations encompass relationships in which one person's effort will benefit another or in which collaborative effort is required.... Not all such situations, however, amount to relations of agency within the legal definition.

Restatement (Third) of Agency • 1.01 cmt. b (Tentative Draft No. 2, 2001). One key difference between relationships covered by the non-legal and legal definitions of agency is that the latter involves relationships in which the principal is capable of controlling the activities of the agent. *See id.* at • 1.01 & cmt. c.

[22] *Cf.* Robert H. Sitkoff, *An Agency Costs Theory of Trust Law*, 89 Cornell L. Rev. 621, 636 (2004)(analysis of trust law "[u]sing the vocabulary of agency in economic rather than legal parlance").

[23] Agency law defines certain legal powers and potential liabilities created when two or more persons enter into an agreement that one of them (the agent) will act on behalf of the other (the principal). In modern settings where many complex tasks are accomplished by groups of coordinated actors, many important societal functions are accomplished by agents acting in part under the governance of agency law. For example, agency law covers such common relationships as those between employer and employee, corporation and officer, client and lawyer, and partnership and general partner. *See* Restatement (Third) of Agency • 1.01 cmt. c (Tentative Draft No. 2, 2001).

[24] Agency law defines a variety of relationships between principals and agents and between those parties and outsiders:

> "As defined by the common law, the concept of agency posits a consensual relationship in which one person, to one degree or another or respect or another, acts as a representative of or otherwise acts on behalf of another person with power to affect the legal rights and duties of the other

However, since it presumes some direct interaction and (generally) contracting between principal and agent, agency law is not sufficient to cover innovation processes in which innovators lacking prior contacts with technology users pursue the interests of those users as agents in creating useful advances. In these circumstances, the agency relationships between innovators and innovation users must be defined by means other than contract terms and related agency law provisions. As described in this article, the applicable agency features are defined in part via patent rights, which substitute for some of the contract terms and agency law provisions that might have resulted had innovator and innovation user dealt with each other directly. Hence, while patent laws and resulting rights serve functions parallel to directly negotiated agency contracts and resulting agency law consequences, patent-mediated agency relationships of the types described in this article do not depend on either contract or agency laws.

C. An Analytic Starting Point for Understanding Innovation-Focused Agency Relationships: A Single Principle-Single Agent Innovation Contract

Because they serve similar functions in promoting innovation and are somewhat easier to understand, contract-based agency relationships targeting innovation offer a useful introduction and comparative introduction to patent-based agency relationships. This subsection describes a simple form of contract-based agency relationship aimed at promoting innovation. This simple relationship will be used to illustrate some of the basic features of agency processes promoting innovation. The same agency features appear in more complex forms in patent-based agency processes promoting innovation.

The simplest form of contract-based agency arrangement for innovation is a single principal-single agent contract calling for a person with technical expertise (the agent) to create a new item serving some need of an intended user (the principal). A contract for this type of effort is essentially a custom product design and production contract calling for work "on spec" – that is, for the creation of an item meeting certain design specifications dictated by the acquiring party. The designer is expected to act as the agent of the acquiring party in the course of specifying design criteria and producing a workable overall design. The acquiring party will, if a successful product is produced, receive the resulting item (and perhaps control the rights to produce further units of that item). As the benefitted party, the acquiring party will be the principal benefitting from that agent's design efforts. The fee promised to be paid to the designer upon successful completion of the contract creates incentives encouraging the designer to keep the interests of the acquirer in mind while carrying out the contract and aligns the interests of principal and agent in this context.

This type of simple agency arrangement includes three essential features found in all agency relationships for innovation: 1) a definition of the actions or results desired from the agent pursuing innovation, 2) the means and criteria the principal will use to evaluate the efforts or results of the agent as a basis for authorizing payments to the agent, and 3) and the amount of the fees or other rewards the agent will receive for successful performance.[25]

> person. The person represented has a right to control the actions of the agent. Agency thus entails inward-looking consequences, operative as between the agent and the principal, as well as outward-looking consequences, operative as among the agent, the principal, and third parties with whom the agent interacts."

Restatement (Third) of Agency § 1.01 cmt. c (Tentative Draft No. 2, 2001).

[25] *See* Kenneth J. Arrow, *The Economics of Agency* in Principals and Agents: The Structure of Business 37, 37 (John W. Pratt & Richard J. Zeckhauser eds. 1985).

Reliance on an agency relationship for innovation in this way can realize several types of benefits for a principal, including shifting risks of project failure, adjusting reward patterns to the preferences of innovation providers, and allocating innovation efforts to the low-risk provider. The features of these benefits are described more fully in the remainder of this subsection.

1. Shifting Risks of Failure

An agency contract is a means of shifting specific risks of innovation failure from the principal involved to the agent. If an agent pursues innovation, but is unsuccessful in these efforts and does not achieve the results that trigger the right to a reward, the expense and opportunity costs associated with the innovation attempt will be borne by the agent and the principal will be out nothing. In contrast, if the principal undertook similar innovative efforts on her own, she would bear the risks of failure. Hence, agency contracts are means to shift risks of innovation failure to agents. Rewards provided to agents must be sufficiently large to compensate the agents for the risks they take in seeking innovation.[26]

In this risk shifting, various allocations of innovation risks between agents and principals are possible by adjusting whether agents are paid for their efforts regardless of their ultimate success in producing useful innovations. This type of arrangement limiting (or even eliminating) the risks born by innovation agents is present in many large companies that pursue innovation. Corporate principals sometimes pursue innovation inside their companies, acquiring all rights to innovations that produced by their employee-agents. They typically provide those agents with relatively guaranteed salaries and supporting resources to carry out innovation efforts. If a given innovation project fails under these circumstances, it is the corporate principal that bears the loss. By contrast, where outsiders attempt to develop a new innovation and to later convince a corporation to acquire rights in the innovation (usually to utilize the corporation's resources to enable large scale production and sales of the innovation) the outsiders bear the full risks of failures of their innovation efforts.

2. Adjusting Contingent Innovation Rewards to Reward Preferences

Agency contracts can also be means to structure the timing and nature of rewards to accommodate the specific risk preferences of innovators. This type of adjustment can be achieved by including within innovation rewards packages various combinations of fixed rewards for innovation efforts (in which instance innovators only bear the risks of not completing the indicated efforts) and contingent rewards dependent on the success of an innovation (in which instance innovators share the full risks of innovation failure).

The objective of optimal reward structuring is to provide rewards to agents carrying out innovative efforts that are sufficient to encourage cost effective innovation efforts. There are two ways to accomplish this: 1) linking the payment of rewards to the innovators to the completion of innovative designs with significant practical value to users of the innovations or 2) linking rewards to efforts by the innovators that are highly likely to produce useful designs. A strategy that rewards only useful results delays the "settling" of the innovator's reward to the completion of an innovation project when the nature of the results and their value to users can be measured with some accuracy. A strategy that rewards efforts tending to produce successful innovations focuses on rewarding progress, with the advantage of giving an innovator some interim compensation as a project progresses and as the innovator commits more and more time to the project. The disadvantage of a strategy rewarding efforts per se is that the relationship between efforts and results may be poorly understood. As a consequence, efforts may be

[26] *See generally* Steven Shavell, *Risk Sharing and Incentives in the Principal and Agent Relationship*, 10 Bell J. of Econ. 55 (1979).

rewarded that are ultimately unproductive and that have little impact in promoting a successful innovation result. Hence, in innovation settings, triggers for agent payments that turn on results achieved for users rather than mere efforts supporting innovation are typically more likely to drive innovators to consider the interests of innovation users at all stages of innovation projects. A reward scheme that promises an agent a meaningful fraction of the net new utility his or her advance will realize for users will tend to cause a risk neutral agent to pursue efficient types of innovation on behalf of the principal. The agent will tend to see the interests of the user (in the net new utility) as the agent's own interest, with the result that the agent will focus and calibrate his or her efforts in accordance with the utility implications for the user.

Where an agent pursuing innovation is risk averse, having such a party bear the complete risk of innovation failures will generally cause him or her to pursue a less than optimal level of innovation as a means to reduce the associated risks. To encourage greater effort without increasing the net risk to a risk averse agent, a principal can agree to give the agent both a flat fee to compensate for some of the agent's risk taking and a further contingent fee to be paid upon production of a successful innovation. The flat fee component of this arrangement will reduce the innovator's net risk, thereby matching the risk adverse preferences of the innovator. Assuming that effort undertaken by an agent can be measured by a principal in a costless yet accurate fashion, optimal results will follow if 1) the agent is paid a flat sum if the agent adopts a pattern of effort which is likely to produce a successful innovation and 2) a further contingent reward is paid if the agent produces a successful innovation with widespread practical implications and usage corresponding to significant aggregate user gain.[27]

3. Limiting Rewards to Confirmed Project Success

Another key variable in contractually-defined agency relationships promoting innovation is the triggering criteria for results-oriented rewards given to an agent and the corresponding strength of the bond between the interests of the agent and those of the principal. Where an agent's reward is fully dependent on delivering an innovation with tangible benefits to the principal and the amount of the reward approximates the value of the benefits, the interests of the principal and agent will be fully aligned. The agent will tend to conform his or her actions to those tasks that the agent expects will be most likely to increase the benefit for principal and enhance the associated reward for the agent.

However, where (due to either poorly defined criteria for granting rewards or poor monitoring of whether desirable results have been achieved) rewards are paid to agents without desirable results having been achieved for their principals, there is a substantial chance that potential innovators will take the minimum actions necessary to qualify for the rewards, but few steps beyond this. Under these circumstances, less than optimal levels and types of innovative efforts may result as agents pursue the conduct that will further their own interests, but not necessarily those of their principals. Hence, reward criteria and monitoring accuracy are always in tension with the success of agency processes for innovation. As will be seen, patent rights and the commercial market testing for products such rights enable provide some solutions for these problems.

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[27] The otherwise limiting effect of an agent's risk aversion is overcome in this type of arrangement by relieving the agent of an element of project failure risk. Payments rewarding the agent for efforts rather than results shield these payments from project failure risks and lessen the overall risks of the project to the agent. Where agents capable of innovation are risk averse – as will often be the case for individuals who may not want to put all of their income potential and associated wellbeing on the line in connection with a single innovation project – incentives capable of attracting agents to innovation projects and promoting the most efficient innovation efforts possible may require the use of a reward schedule that isolates innovators from some risks of project failure and rewards innovators for completion of success-promoting efforts in their own right. *See* Steven Shavell, *Risk Sharing and Incentives in the Principal and Agent Relationship*, 10 Bell J. of Econ. 55, 56 (1979).

4. Allocating Innovation Attempts to Low-Risk Providers

Agency arrangements for innovation are also means for allocating innovation projects to the low-risk providers of innovation services. These arrangements allow parties with superior expertise in given fields to apply that expertise in ways that heighten the chances for innovation success over the chances for success otherwise possessed by a principal. A person with expertise in a field may possess knowledge that allows him or her to narrow attempted innovation efforts to those with a high likelihood of success. Alternatively, a person with special expertise or skills may be able to complete innovation attempts more quickly in a given period, thereby at least testing alternatives quickly and eliminating failures rapidly. Under conditions where innovation must be completed in a specific time or with limited resources, this type of increased speed of innovation attempts will tend to increase the chances for success in a particular innovation project. Either of these consequences of enhanced skill will reduce the expert's risks in taking on an innovation attempt relative to the risks that would be borne by less expert principals if they were to attempt a similar innovation project. Indeed, the need for the exceptional skill or knowledge of an agent in a particular area to direct and complete complex research is often the basis for an agency relationship aimed at innovation and the willingness of a principal to pay an agent a considerable sum for the latter's services.

This type of trading on the expertise of an agent with an eye towards the projected value of products of that expertise is not limited to technical innovation. It forms the bedrock for many professional fields, including the practice of law. For example, in making legal arguments or crafting legal documents, a client typically relies on the superior expertise and skill of an attorney to produce successful results that have specific projected value to the client. While both a client and his attorney may fail in such tasks, the risks of failure of an inexperienced client in making his own legal arguments or drafting his own legally significant documents will generally be much greater than the possibility of failure (that is, a poor legal result) on the part of an experienced lawyer.

Hence, while there is still some residual risk of failure when a complex innovation task is performed by a party with superior knowledge concerning the task, the shifting of a task from principal to agent can be a means to allocate tasks to the low-risk provider and thereby reducing the risk of innovation failure. By reducing the number of failed innovation attempts and resulting losses of resources, such task shifting and risk reduction (achieved by matching innovation attempts with pre-existing expertise and skills aiding in those attempts) should produce corresponding increases in the efficiency of innovative processes.

D. Limiting Breakdowns in Innovation Contracting

A number of factors may impede the formation of incentive contracts establishing agency relationships for innovation. While all of the relevant reasons for contracting breakdown are not discussed here, the circumstances addressed in this section are commonly encountered reasons why contract-based innovation relationships may be difficult to form (and why patent-based substitutes for these relationships may be particularly valuable).

1. Difficulty in Identifying and Targeting Capable Innovators

Even in the forming the simplest of agency relationships involving one innovator working on behalf of one potential innovation user, gaps in information about the capabilities of potential innovators may preclude finding a qualified innovator and lead to breakdowns in contracting processes. Transaction costs of finding a qualified expert and including that expert in an innovation project may be too high. The relevant innovation users may lack the information (or the resources needed to generate the information)

required to identify the relevant innovators. A disabling information gap may result from either 1) a lack of information about who has the relevant skills and knowledge to produce a particular type of advance or 2) from doubts on the part of potential innovation users about the veracity of information revealed by innovators about their qualifications (as where experts assert a level of expertise but lack a track record of proven results that would confirm a likelihood of being able to produce a desired type of advance). Without sufficient information signaling who has the needed abilities and, therefore, who to contract with, potential users of advances will tend not to form agency contracts for completion of innovation projects.

A system of patent-based innovation efforts will tend to overcome this problem by simply creating contingent rewards for successful innovation, with the size of the rewards scaled to the value of innovations to users, but with no need for users to contact innovators in advance of innovation projects. Potential innovators will see the relevant contingent rewards and self-identify themselves by starting innovation efforts under this system. Innovators will tend to reveal (and, indeed, advocate) the value of their invention results via commercialization efforts that portray the uses and value of advances. Innovators will be motivated to both increase and reveal the value of their advances because patent-based rewards are maximized by creating commercially valuable advances that are popular with users. Initial information uncertainty is resolved by performance. In this regard, the patent system establishes an equivalent of a unilateral contract offer that can be accepted by any party producing a commercially valuable advance that has the features such as novelty and non-obviousness required to qualify for a patent. The patent process is the economic equivalent of a bounty system, with the bounty payment realized through the combination of creation of a new advance and commercialization and popularization of that advance to place it into the hands of many paying users.

2. Overcoming Problems in Forming Group Contracts

Even where a relevant innovator with sufficient technical skills is identified, formation of a contract incentivizing this party to pursue a useful advance on behalf of multiple potential users may be difficult because of strategic behavior among the users. Each user may hold back, hoping to get other users to pay for innovation expenses and then using the resulting advance at a low cost. Ideally, where multiple users share a need for a particular type of advance, they should share the cost of subsidizing the research needed to satisfy this shared need. The group will benefit if the aggregate costs of research do not exceed the aggregate incremental value of an advance to the group members. A payment scheme that entailed joint contributions to such a research project up to the level of their perceived potential gains would allow a group to act as a single principal in a contractually-defined agency relationship with the targeted innovator.

Unfortunately, the formation and administration of this type of group contracting for innovation will often be problematic. Both information gaps and strategic behavior may prevent potential invention users with like invention needs from finding each other and presenting joint incentives to a contractually engaged innovator serving the user group.

a. Finding Relevant Group Members

Transaction costs in identifying innovation users with similar technological needs will hinder such group contracting by limiting the scope of invention user groups to less than the full range of potential users. Some interested users will not be found and will be omitted from potential contracting groups, leading to amounts of contractual incentives for innovation that are smaller than if all potential users' interests were reflected. By excluding some users, partial user groups will also exclude some incentives for innovation. The resulting incentives will be less than the optimal rewards as measured by the full potential usefulness (and societal value) of an advance under development. With the less than optimal incentives imbedded in innovation contracts (or contract offers), some desirable innovation

projects will not be initiated (because they seem not to have net value given the limited number of parties organized to pay for them) or will be pursued with less than optimal levels of resources and efforts (because they are cost-effective to complete in a limited form, but not with the full level of efforts that funding by all of the interested users would have supported).

To illustrate this point, consider an advance that has projected usefulness to approximately 10000 similar businesses. For simplicity, assume that each of these businesses would expect to gain approximately $1000 from the advance. If all were involved in a contracting effort to encourage creation of the advance, the users as a group would be willing to collectively pay a bit less than $10,000,000 ($1000 x 10000) to reward someone for development and delivery of the advance. A contract establishing a promised payment of about $10,000,000 upon successful delivery of the advance would be cost-justified at the group level (in the sense that the group would receive more back in aggregate value gained than it paid out in development costs for the innovation effort).

However, if contracting problems preclude banding together all of the interested firms in this way, a fraction of the group contracting for the same innovation might offer only a smaller payoff upon successful production of the advance. This smaller promised reward would tend to prompt less substantial efforts to produce the advance. For example, suppose that (even though there are actually 10,000 similarly situated firms) a party needing an advance only identifies and reaches a joint-development agreement with 9 other firms that also need the advance. Managers of the first company work in conjunction with the 9 other firms to establish a joint contracting effort seeking design and production of the advance in question. The maximum reward that will be cost justified for the 10 firms to offer is $10,000 ($1000 x 10). The incentives created by embedding terms for this type of contingent contractual reward in a contract for production of the advance will encourage only a fraction of the innovation development effort that a more inclusive contract and larger reward would incentivize. Better information leading to the involvement of more potential invention users in the payment of innovation rewards will tend to produce larger contingent rewards and incentivize greater innovation efforts. By contrast, information constraints limiting the identification of potentially interested users will impair the formation of contracting groups and correspondingly restrict the effectiveness of these groups in promoting innovation efforts by agents at efficient levels reflecting the full potential value of advances to their complete set of users.

This type of information limitation on identifying contracting parties will tend to impair the formation of complete innovation contracts and the creation of optimal contractual incentives for invention where the full set of potential users for an advance is either 1) numerous, motivated by diverse product detail preferences, or isolated in separate industries or operating environments. In these situations, identifying parties with like needs for a specific advance may be particularly difficult as the necessary fact finding will extend across numerous situations or parties. Where the resulting information-gathering barriers are large, the formation of complete contracting groups for the incentivizing of innovation will be correspondingly hard and frequently unsuccessful. In these settings where contractual incentives are likely to be absent or at low levels not reflecting the full value of potential advances, the need for patent incentives as substitute sources of innovation incentives will be particularly great.

b. Group Formation Problems Due to Negotiation Difficulties

Even if the similarly situated parties with joint interests in a new advance can be identified, some of these parties may refuse to participate in a group innovation contract (or seek to participate without paying their share of innovation incentive costs) due to problems in identifying and sorting out the relative roles (and payment obligations) of the group members in a joint innovation project. These relate to problems that will surface as the potential group members seek to negotiate their specific roles and contractual obligations in carrying forward an innovation project.

Negotiations over a group project may founder over the specification of many types of inter-party terms, including disagreements between the parties about how much benefit each will obtain from an innovation being sought and how much each should pay for its development. Each party may attempt to downplay the gain that they will receive from the innovation at issue in hopes that their fellow contributors would bear most of the reward "costs" of producing the innovation. These sorts of strategic choices of the potential contracting parties may keep them from reaching agreement on appropriate reward levels. As with information barriers that precluded the formation of innovation contracts with incentives reflecting the full value of an advance to potential users, strategic behavior that similarly limits the involvement of all innovation users and the amounts that the contracting users will pay to a successful innovator are likely to impair or preclude the development of some advances with net social value (taking into account the aggregate benefits to all potential users).

c. Group Formation Problems Due to Strategic Behavior

The formation of a complete contracting group promoting innovation by an agent may also be impeded due to the strategic behavior of potential group members. Some of the parties potentially benefitted by an advance may refuse to participate in a group innovation contract (or seek to participate without paying their share of innovation incentive costs) due to strategic behavior aimed at gaining an advantage over their fellow group members. Each interested party may follow a strategy of trying to get as much return from an advance as possible by seeking to throw the main costs of innovation rewards on the other contracting parties in the group. Each potential user will have incentives to seek access to innovations without sharing in the innovation costs, meaning that there will be strong advantages to holding back, not joining the innovation contracting groups (or nominally joining these groups but avoiding performance of obligations to pay portions of innovation rewards). If successful in these efforts, the users will obtain the benefits of innovation as “free riders” who have not paid for the associated costs of innovation. This type of strategic maneuvering may preclude the formation of a group innovation contract or lead to one that involves so few potential users as to severely under fund and under incentivize the resulting innovation efforts.

5. Costs of Defining and Administering Group Innovation Contracts

Assuming that a group of parties with shared interests in potential type of innovation are willing to attempt a group innovation contract with an agent, several types of contracting difficulties may arise and consume resources that would otherwise be devoted to the creation of incentive payments for innovation. These problems may also reduce innovation rewards below optimal levels (taking into account the full range of benefits available from a particular innovation). The following types of problems may arise in defining and administering the terms of innovation contracts involving groups of potential innovation users who are obligated to pay innovation rewards to agents producing advances.

a. Disputes Over Contract Terms

The negotiation of specific terms of a group innovation contract may be difficult because this process will force group members to agree on terms that will often be in dispute. Negotiation of essential contract terms may force potential innovation users to focus on differences in the characteristics and interests of the various users and their corresponding desires for different contract terms. Differences of interests – and corresponding differences in desired contract terms for innovation contracts – may concern such key topics as the nature of the innovation being sought, the circumstances constituting successful contract performance under which contingent payments will be due as innovation rewards, the administrative arrangements under which contract participants will pay portions of innovation rewards, and the types of information about and control over an innovation that contracting parties will have if a

successful innovation is produced. Even if parties with diverse characteristics can come to agreement on these key features of a group innovation contract, the specification of such complex terms among a substantial number of potentially diverse users will require difficult and costly transactional steps, with corresponding decreases in the amounts of innovation rewards and reductions in the effectiveness of resulting innovation incentives.

b. Contract Administration Costs

Assuming that a group contract can be established calling upon an innovator to produce an advance on behalf of a group of potential users, the provisions of such a contract must still be administered. Both measurement and administration costs associated with the incentive payment processes established under an innovation contract may also undercut some of the value of such contracts. Amounts spent on these tasks will reduce the amounts devoted to innovation incentives with a resulting lessening of incentives below efficient levels.

Several steps in the administration of group contracts for innovation will require the completion of difficult and costly conduct and item measurement. Parties contributing portions of contingent payments under innovation contracts will want their contributions and those of other parties carefully accounted for in accordance with their joint contract terms. The willingness of each to make their own payments will depend in part on the firmness of the accounting mechanisms and the trust that they place in those mechanisms. Hence, these measurement and administrative processes will need to be substantial and will be likely to contribute significant costs to the administration of innovation contracts involving multiple innovation users and incentive payers.

Similarly, significant measurement steps and costs may arise in carrying out the terms of contingent innovation contracts. The success of an innovator working under such a contract must be monitored carefully to determine if he or she is entitled to the contingent innovation rewards specified in the contract. This will sometimes involve expert analyses of innovation products, with corresponding fees paid to the experts. Both the innovator and the potential users who are parties to a group innovation agreement will have strong interests in having evaluations of innovation results performed thoroughly and fairly. Potential innovators will fear that poorly performed evaluations will improperly deprive them of innovation reward payments (after having incurred considerable efforts and expense to produce a successful advance). Potential users will worry that inaccurate evaluations of innovation results tendered under a contract will result in reward payments for what were really inadequate submissions.

Erroneous evaluations that result in over- or under-payments of invention rewards will undercut the effectiveness of contract-based agency processes in aligning innovators' interests with those of innovation users. This type of misdirection of agency efforts – producing complacency in innovators who can expect payments without actually producing successful innovations and deterring diligent efforts by innovators who fear non-payments despite successful performance – will tend to undercut the success of contract-based agency processes for innovation. Even where insecurity over contract payments is overcome by careful evaluations of innovations as preliminaries to payment commitments, these careful evaluations will add costs to the administration of innovation contracts and reduce potential innovation rewards accordingly.

E. Patent Rights as Substitutes for Agency Contracts in Cases of Contracting Breakdown

Against the backdrop of contractual agency arrangements just described (and the difficulties in forming and administering these arrangements), the potential advantages of patents as vehicles for non-contractual agency relationships furthering innovation becomes clear. Patents can be incentive creators when contracts cannot be. Patent-influenced processes promoting innovation create agency relationships

in which legally-created promises of patent rights and rewards link the interests of invention providers to invention users. Patent rights establish incentives that make innovators agents of principals who are the users of innovations. Patent rights create the incentives for innovators to target, perfect, commercialize, and distribute inventions that are useful and popular with numerous users. Innovators are encouraged to think like agents of invention users, seeking always to answer the question "How can I produce an advance that will provide the greatest beneficial results for users?" The notion of what constitutes a beneficial result – including such features as item cost, ease of use, and value of results obtained – will be measured from the perspective of users, not innovation producers. Hence, patent rights (and the commercial value in advances that they create) cause innovators to perceive invention users' interests as the innovators' interests as well. Patent rights align these interests in the same ways as contract incentives align the rights of innovators and invention users under innovation-focused agency contracts.

By using what we already know about the dynamics of agency contracts (from the extensive study of contractual agency relationships to date), we can project many agency features of patent-mediated agency processes. By modeling patent incentives and their agency consequences in terms of their contract-based counterparts, we can gain valuable insights into the ways that patents influence innovation. We can also use this analytic perspective to better tailor the scope and force of patent rights to optimize agency efforts leading to valuable innovation.

Patent rights are most needed as substitutes for agency contracts promoting innovation in situations where the formation of agency contracts for innovation is problematic and unlikely.[28] While contracts are capable of more careful and detailed tailoring to the circumstances and needs of particular innovation users, where contracts incentivizing innovation are unlikely to be formed (or will be formed with only a fraction of the relevant beneficiaries, potentially leading to far less than optimal incentive payments), other innovation incentive mechanisms may play a valuable role.

Patents provide a means to extend important innovation incentives and agency relationships beyond the realm of contracts. The incentives created by patents may be best thought of as contractual substitutes for use as innovation drivers in settings beyond the realm of likely formation of agency contracts for innovation. Put simply, patent rights are solutions for innovation promotion in cases of contracting breakdown between innovators and innovation users. Ideally, to fulfill their potential as contractual substitutes, patent rights will establish contingent payment terms for successful innovators that approximate the contractual payment terms and incentives that innovators and innovation users would choose if they could enter into contracts will perfect information and no transaction costs or strategic behavior. Under this model, patent rights should be triggered (and have projected scope and commercial value) similar to the incentive and performance terms that principals who are potential innovation users would offer to potential innovators where the principals able to contract the innovators and offer the terms.

III. Expanding Innovation Analyses via Agency Theory

[28] Patent rights may serve a valuable function even where some contractual incentives for innovation are available. Assuming that both contractual and patent incentives are available for the production of a given type of invention, these incentives may not be equivalent. Contract incentives created by a particular user or group of users will reflect the needs and invention value of an advance to just these users. The incentives created (and the force on innovators and innovation efforts) will be curtailed and biased accordingly. By contrast, the incentives promised by patent rights will tend to reflect the full range of uses and commercial value of an advance since these can be controlled once a patent is in place. In this respect, patent rights create broader and more complete incentives than most contractually created innovation incentives even where both are available.

A. Agency Theory as an Analytic Tool

Agency theory provides an organized means to summarize and study the salient features of situations (including patent-mediated innovation) where one or more parties (the agent or agents) act to further the interests of one or more other parties (the principal or principals).[29] Agency theory provides useful accounts of the causes and consequences of goal incongruence in principal and agent relationships.[30] It can also assess how information flows and risk allocations affect the effectiveness of agency relationships.[31]

In applying agency theory, it is important to remember that this theory is not limited to contractually created agency relationships. An agency relationship capable of assessment through agency theory is present wherever one party controls an outcome of interest to a second and the first party's efforts are incentivized via contingent rewards tending to encourage the first party to pursue the interests of the second.[32] Hence, non-contractual, but patent-influenced relationships in which innovators are incentivized to advance the interests of invention users are instances of agency relationships that can be evaluated and improved using agency theory.

Much of the agency theory literature has focused on three aspects of principal-agent relationships: (1) the preferences of principals and agents in these relationships (including means to alter the preferences through contingent reward provisions), (2) the uncertainties present in principal-agent relationships and their impacts on participants in these relationships, and (3) the information flows within principal-agent relationships and from surrounding environments that influence the success of these relationships.[33] Studies have also examined means for risk sharing within principal-agent relationships, the features of

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29 For overviews of agency theory and the types of problems the theory can address, see Hal R. Varian, Intermediate Microeconomics: A Modern Approach 667-88 (6th ed. 2003); Kenneth J. Arrow, *The Economics of Agency*, in Principals and Agents: The Structure of Business 37-51 (John W. Pratt & Richard J. Zeckhauser eds., 1985); Kathleen M. Eisenhardt, *Agency Theory: An Assessment and Review*, 14 Acad. Mgmt. Rev. 57 (1989). A number of scholars have used agency theory to analyze legal problems. *See, e.g.*, Howell E. Jackson et al., Analytical Methods for Lawyers 88-100 (2003); Robert H. Sitkoff, *An Agency Costs Theory of Trust Law*, 89 Cornell L. Rev. 621 (2004); Eric A. Posner, *Agency Models in Law and Economics*, in Chicago Lectures in Law and Economics 225 (Eric A. Posner ed., 2000); Easterbrook, *Insider Trading as an Agency Problem*, in Principals and Agents: The Structure of Business 81, 87-98 (John W. Pratt & Richard J. Zeckhauser eds. 1985).

30 *See* J. B. Barney & W. S. Hesterly, *Organizational Economics: Understanding the Relationship Between Organizations and Economic Analysis*, in Handbook of Organizational Studies 115, 115-147 (S. R. Clegg, C. Hardy, & W. R. Nord eds. 1996).

31 *See* K. M. Eisenhardt, *Agency Theory: An Assessment and Review*, 14 Academy of Mgmt. Rev. 57, 57-74 (1989).

32 *See* Steven Shavell, *Risk Sharing and Incentives in the Principal and Agent Relationship*, 10 Bell J. of Econ. 55, 55 (1979)(noting that contractually-induced agency relationships are only a subset of all such relationships and that the essential features of agency relationships (possessed by both contractual and non-contractual agency relationships) are that in an agency relationship 1) a principal enjoys the outcome of an agent's actions, 2) the success of the agent's actions in promoting the principal's interests is determined by a combination of the agent's efforts and additional uncontrolled circumstances not controlled by the principal or agent, and 3) to encourage favorable efforts, the principal commits to pay the agent a fee upon the completion of efforts or the attainment of results that advance the principal's interests).

33 *See* Michael C. Jenson, *Organizational Theory and Methodology,* Accounting Rev., April 1983, at pp. 319-339.

optimal contracts between principals and agents, and welfare comparisons of equilibrium contracting solutions to agency relationship formation with and without information costs.[34]

Additional studies have used agency theory to predict the impacts on principal-agent relationships of changes in surrounding environments. Changes considered in these studies have included alterations in contracting environments, changes in the technologies used to monitor agents' actions and trigger performance rewards, and shifts in the bonding arrangements used to signal commitments by agents to particular courses of conduct.[35] Similar studies have also examined the impacts on principal-agent relationships of variations in the capital intensity of surrounding business enterprises, the specialization of business assets, information costs, features of capital markets, and characteristics of labor markets.[36]

An additional theory related to agency theory has also been applied to evaluate corporations and other organizations that operate through the actions of multiple agents. This theory treats an organization or "firm" as the nexus of numerous agency relationships. The formation of principal-agent relationships within a given firm (and the specification of the terms of those relationships) are treated as the results of numerous agency-tailoring decisions. Ideally, the resulting set of principal-agent relationships will constitute an equilibrium condition in which the firm's agency features maximize the operating benefit to the corporate organization. Analyses employing this theory focus on both the means to make particular principal-agent relationships more effective in corporate business activities and further means to adjust the terms and content of one corporate agency relationship relative to another.

Finally, some agency studies have evaluated agency relationships constructed and administered through non-contractual processes. In these processes, a party or body (such as the government) creates agency relationships by setting up contingent rewards through non-contractual means. The contingent rewards are constructed so as to encouraging one party to act on behalf of another. Parties tend to respond to promises of non-contractual rewards much like they respond to similar contract-based rewards. Where the payment of the rewards is tied to completion of actions of interest to particular principals, parties in both circumstances tend to act as agents and align their conduct goals with the interests of the principals. Hence, many features of agency theory developed for evaluations of contract-based relationships can be used to study and evaluate agency relationships created via non-contractual means.

Patent-mediated innovation relationships linking innovators and innovation users are examples of non-contractual principal-agent relationships. Patent rights create the contingent rewards that energize agency behavior. Unfortunately, non-contractual agency arrangements such as these have rarely been assessed as agency processes. Hence, it will frequently be helpful to look to studies of contract-based principal-agent relationships for insights about agency dynamics and design features that can be carried over into the less well understood area of patent-influenced principal-agent relationships.

B. Key Characteristics of Principal-Agent Relationships

1. Establishing Agency Incentives and Aligning Principal and Agent Interests

For purposes of agency theory, each party acting as a principal or agent in a principal-agent relationship is modeled as a rational actor pursuing his or her own interests. These interests are defined by the values of the participants in the relationship, background environmental features surrounding the

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34 *See id.*

35 *Id.*

36 *Id.*

relationship, and the rewards and incentives created by the terms of the relationship.[37] Each participant's perception of his or her self-interest and how to pursue it is also shaped by the information set available to that individual.[38]

Acting within an agency relationship, an agent controls the nature of his or her conduct and, hence, the degree to which the conduct furthers the interests of the principal. These conduct choices are fundamental features of the relationship. A principal can influence these choices – and how closely the agent's conduct adheres to the interests of the principal – by adjusting the amounts and triggers for rewards or fees that encourage an agent to undertake particular efforts within an agency relationship.[39] Payment of rewards or fees can be triggered by attainment of specific results desired by principals (such as occurs with sales commissions paid to company employees for completion of specified volumes of product sales) or for the completion of efforts that are steps towards results desired by principals (such as occurs with salaries paid to personnel in the advertising department of a company whose work on advertising efforts is hoped to support sales transactions elsewhere in the same company).[40]

If the specific results desired by a principal are known at the outset of an agency process (or at least the actions by an agent that the principal projects will be most likely to serve the principal's goals are known), several additional features of a principal-agent relationship can be adjusted and refined to best assure attention by the agent to the preferred result or action. Adjustable relationship features include: 1) the minimum rewards needed to get an agent's threshold attention and to cause the agent to consider how to pursue the principal's activities, 2) the amount of contingent rewards payable upon attainment of desirable results or upon the completion of efforts tending to produce the results, 3) the circumstances triggering payment of rewards to the agent, 4) means for gathering information on the agent's performance and for evaluating that information and transmitting the evaluations to the principal, 5) mechanisms for gathering information on circumstances surrounding the agent's actions (to the extent that this circumstantial information is relevant in evaluating the appropriateness of the agent's actions), 6) the risk aversion levels of the principal and agent, 7) the allocation between principal and agent of risks of failure of agency-related activities, and 8) additional payments to agents to encourage them to bear risks

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37 *See* K. M. Eisenhardt, *Agency Theory: An Assessment and Review*, 14 Academy of Mgmt. Rev. 57, 57-74 (1989)(noting that, in agency theory analyses, principals and agents are typically assumed to be 1) subject to bounded rationality, 2) self-interested, 3) opportunistic, and 4) risk averse).

38 *See id.*; Stanley Baiman, *Agency Research in Managerial Accounting: A Second Look*, 15 Accounting Org. & Soc. 341, 342 (1990).

39 In general, principals can align agents' interests with those of the principals and minimize agency costs by offering the agents a share of the benefits achieved through the agents' actions. *See* J. B. Barney & W. S. Hesterly, *Organizational Economics: Understanding the Relationship Between Organizations and Economic Analysis*, in Handbook of Organizational Studies 115, 115-147 (S. R. Clegg, C. Hardy, & W. R. Nord eds. 1996).

40 Outcome based arrangements -- in which the fee paid to an agent depends on the attainment of an outcome that is desirable from a principal's perspective -- tend to align the interests of principal and agent. However, these types of fee schemes sometimes make agents more risk averse by putting them at risk of failures due to factors outside their control – that is, by putting their attainment of fees within the agency relationship at risk of failures by other parties contributing to the outcomes that will trigger the fees. By contrast, fee schemes that provide for payments to agents based on efforts tending to promote successful results regardless of whether those results are attained tend to promote greater risk taking by agents since they need not be concerned over risks outside of their own actions. *See* K. M. Eisenhardt, *Agency Theory: An Assessment and Review*, 14 Academy of Mgmt. Rev. 57, 57-74 (1989).

of failure regarding the pursuit of the principal's interests that the agents would not otherwise be willing to accept.

Agency theory models the operation of agency relationships in terms of these (and other) agency features. Agency theory helps to define the incentive problems in these settings which will be relevant in considering the optimal innovation incentives potentially derived from patent laws. In addition, agency theory provides means to predict the impacts on agency behavior of various adjustments to agency terms, including the types of changes in agency relationships that may follow from alternations in patent law standards and resulting innovation rewards.

To see how agency theory can help us understand patent-mediated agency processes, it is useful to consider the key features of a simple agency relationship as seen through the lens of agency theory. Agency theory helps to reveal the important functional features of such a relationship, suggesting the levers and problems governing the operation of such a relationship. Consider the following simple agency arrangement.[41] A real estate agent is engaged to sell a home by the home owner under a contract calling for the agent to receive a commission of 5 percent of the sales price upon successful completion of the home sale. Under these circumstances, the agent is encouraged to undertake a specific range of cost-effective actions, with the measure of cost-effectiveness measured from the agent's perspective. For example, the agent will have an incentive to take an action that costs $1 and that improves the projected price realized for the seller by $100 since the agent will predict an increased payoff (and a perceived increase in the agent's own welfare) of $5 from this action. However, the agent will not have an incentive to take an action that costs $10 and increases the seller's price by $100 since the agent will only gain $5 from this action.

The lack of motivation of the agent to take this last action reflects some degree of interest divergence between the principal and agent – that is, a gap in ideal incentives which, if fully successful, would completely align the interests of principal and agent. The action costing $10 would have advanced the seller's interest since the seller's gain was greater than the cost, yet the agent has no interest in pursuing this action. Such a lack of interest is evidence that the fee arrangement between the seller and agent has not perfectly aligned their interests, producing a welfare loss in the operation of the agency arrangement. This welfare loss corresponds to the failure to take the $10 action that would have resulted in a sale of the house for $100 more and a net increase in welfare for the home owner of $100 (which could have been shared with the agent under a different fee structure to compensate the agent for his actions and still have realized a net welfare gain of $100 - $10 = $90). The losses that stem from such misalignments of interests are called agency costs.

2. Agency Costs Impairing Agency Processes

Three types of agency costs generally plague agency relationships and processes. The different types of costs stem from flaws in different components of agency relationships. The three types of agency costs stem from principals' difficulties in monitoring agents' actions (monitoring costs), agents' difficulties in convincing principals of the agents' capacities and trustworthiness (bonding costs), and agents' inattention to some aspects of principals' interests resulting in reductions in principals' welfare below ideal levels (residual costs).

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[41] This example is described in Frank H. Easterbrook & Daniel R. Fischel, The Economic Structure of Corporate Law 91 (1991). *See also* Frank H. Easterbrook & Daniel R. Fischel, *Corporate Control Transactions*, 91 Yale L.J. 698, 701 (1982); Eric A. Posner, *Agency Models in Law and Economics*, in Chicago Lectures in Law and Economics 225, 225-29 (Eric A. Posner ed., 2000).

Monitoring costs and bonding costs are essentially administrative costs of operating agency relationships born by principals and agents respectively. Even in relationships where perfect information was provided to principals and agents, the costs of providing this information would be a drag on operations and reduce the efficiency of these relationships. For principals, costs spent in monitoring the activities of agents and determining when reward payments to these parties are due will reduce the net value of operating through agency arrangements and correspondingly reduce the amounts that principals are willing to pay to agents as reward incentives. For agents, the amounts that they must expend to establish their reputations and retain the confidence of principals are typically expenses that they must bear, meaning that the costs of these tasks will reduce the net value of agency rewards they perceive and receive for being part of agency processes. Both these type of administrative expenses will have the net effect of reducing the net amount and functional impacts of agency rewards, with the ultimate result that some agency relationships that would have been formed and effective without these costs will not be established in light of the reduced value resulting from such costs.

Residual costs are essentially opportunity costs corresponding to actions furthering principals' interests that were encouraged by the net incentives presented to agents and within the capacity of agents, but nonetheless not taken by the agents. Residual costs typically result from a misalignment of the interests of principals and agents. The $100 loss resulting from the real estate agent's failure to pursue actions in the house seller's interest in the scenario discussed above is an example of a residual loss due to the lack of full alignment of the agent and seller's interests. Understanding residual costs in agency contexts requires a consideration of the sources of interest divergence in agency relationships.

3. Sources of Divergence of Interests of Agents and Principals

Divergences of interests between agents and principals may stem from two different types of weaknesses in the ability of principals (or others acting on their behalf) to motivate agents to pursue the interests of principals. First, a principal may inaccurately monitor an agent's performance, resulting in payments of rewards to agents for performance that does not actually serve principals' interests. If agents can count on this type of imperfect monitoring of their performance, their incentives will extend only to the types of performance (and performance features) that can be detected by principals and that will influence the payment and size of rewards for the agents' performance. This type of problem is a version of moral hazard[42] -- that is, a hazard or risk that the agent will act in a manner diverting from the interests of the principal because this divergence is not measured and does not affect the rewards or incentives the agent receives within the agency relationship.[43]

For example, this type of moral hazard leading to flawed agency incentives is present where an employee is given a bonus for completing a certain number of sales calls but the quality of the agents'

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[42] *See generally* Bengt Holmstrom, *Moral Hazard and Observability*, 10 Bell J. Econ. 74 (1979).

[43] The classic example of moral hazard arises in the context of insurance where coverage against a loss may influence an insured party to increase risk-taking behavior because, if a loss occurs with an insurance payoff, that party will not bear the consequences of the loss. Hence, a party insured for fire losses may be encouraged to be lax with fire safety because, should a fire occur, the resulting insurance payment will mean that the insured party does not bear the adverse consequences of the fire. Because insurance relieves him of his incentive for care towards the prevention of fires and the avoidance of harm to others, insurance can have the unexpected effected of making an insured party a poorer agent of community members concerned about preventing fire losses. *See generally* Kenneth J. Arrow, *The Economics of Agency* in Principals and Agents: The Structure of Business 37, 37-51 (John W. Pratt & Richard J. Zeckhauser eds. 1985); R. C. Merton, *An Analytic Deviation of the Cost of Capital of Deposit Insurance and Loan Guarantees: An Application of Modern Option Pricing Theory*, 1 J. of Banking and Finance 3, 3-11 (1977).

actions in making the calls is not monitored. The calls may have been performed in a perfunctory manner that was not likely to increase product sales for the employee's company. In this setting, sales calls are not of interest to the employer *per se*, but the completion of these calls is used as an easily measured surrogate measure for promotion of sales success. Since the performance of company employees is measured in terms of sales efforts (*i.e.*, numbers of sale calls completed), employees are motivated to undertake the measured actions (completed the sales calls), but not to take the further steps needed to complete product sales. Indeed, if their compensation turns primarily on the number of sales calls completed, they will tend to be discouraged from taking these further steps to conclude product sales since they consume time and effort, but do not increase employee compensation.

Divergence of interests of principals and agents can also result from a second type of problem involving "adverse selection" of conduct by agents. "Adverse selection" in this context refers to choices by actions by agents that do not serve principals' interests or that even hurt those interests. This may occur inadvertently, for example, where agents are assigned tasks that they are not qualified to carry out and make poor selections of actions in stumbling through their activities as agents. More serious (and potentially more carefully concealed) adverse selection of agents' actions may occur where agents decide to carry out actions for principals via fraud or other misconduct. This will occur, for example, where agents seek to superficially qualify for rewards within agency relationships by taking actions (such as selling products through fraudulent practices) that qualify the agents for rewards (such as sales commissions), but which ultimately hurt their principals.

An agent may have opportunities to choose actions that poorly serve the interests of a principal where the principal does not have sufficient information to detect this type of adverse choice. A principal may not be able to properly interpret the actions of an agent where the actions take place in a context that is not fully understood by the principal. Where a principal is not aware of the choices of action available to an agent, then the principal will sometimes be unable to detect that an agent has chosen activities that are less than optimal in furthering the principal's interests. In essence, this is an information disparity problem that stems directly from the information collection and understanding gap that often exists between a principal and agent even under the best of agent monitoring arrangements. Divergence in the interests of a principal and agent may result from this information gap due to undetected choices of undesirable actions by an agent.[44]

In the sales context just discussed, for example, if an employee's compensation increases based on the number of sales calls he makes, a typical employee will diligently make and report sales calls in order to boost his earnings. However, an employee may boost his numbers of measured sales calls by conducting some calls, fabricating records for additional calls, and reporting both the real and fake calls as completed efforts. The employer involved may not have sufficient information about the employee's actual sales efforts to appreciate that the employee is sometimes shirking his duties and falsely reporting sales activities. The employee's adverse selection of conduct in failing to pursue some sales calls and falsely reporting completion reflects a divergence of his interests from those of his employer that may go undetected and, hence, undiscouraged by the contingent rewards provided to the employee under the employer's compensation system.

C. Characteristics of Optimal Principal-Agent Relationships

1. Factors Influencing Incentives and Actions

[44] For example, adverse selection occurs when individuals sometimes conceal their illnesses as they seek health insurance. *See* M. Rothschild & J. E. Stiglitz, *Equilibrium in Competitive Insurance Markets*, 90 Q. J. of Econ. 629, 629-50 (1976).

In economic terms, the factors influencing the incentives and actions of principals and agents are summarized by the following equation defining the expected value of actions to a principal (EU(a)) and an agent (EV(a)):[45]

$$EU(f,e) = \int (\int (U(x - f(x,z))dz)\ r(x;e)dx)$$

and

$$EV(f,e) = \int (\int (V(f(x,z),e)q(z|x;e)dz)\ r(x;e)dx)$$

where:

U(a) = principal's utility function (in wealth)
V(b,e) = agent's utility function (in wealth and effort)
e = agent's effort
z = principal's observation of e
x = outcome
f(x,z) = fee paid by the principal to the agent (a function of x (outcome) and z (observation of effort))
r(x;e) = probability density of x given e
q(z|x;e) = probability density of z given x and e

An optimal fee schedule within this construct will be one in which there is no alternative schedule that would make one or both of the parties better while not harming the other party. That is, the aim in this situation is to select a Pareto optimal fee schedule under which the expected utility for the principal and agent cannot be improved without harming the other. In formal terms, this means that the first-best fee schedule is one which solves the problem:

max EU(f,e) over f

subject to

EV(f,e) > or = V_{min}

EV(f,e) is maximized over e

where V_{min} = the fallback utility level that the agent could achieve by undertaking other types of activities. This utility is measured by the agent's bargaining power and market forces which dictate the value of the agent's services in other contexts.

2. Terms of Efficient Incentive Fees

a. Risk Neutral Agents

[45] *See* Steven Shavell, *Risk Sharing and Incentives in the Principal and Agent Relationship*, 10 Bell J. of Econ. 55, 57-58 (1979).

Shavell has shown that, in these circumstances, the choice of an optimal fee schedule linking the interests of a principal and agent depends on whether the latter is risk neutral or risk averse.[46] Where an agent is risk neutral, the optimal approach is to adopt a fee structure that depends only on the results achieved by the agent and which gives the agent all of the resulting benefits from a given outcome, minus a constant amount kept by the principal (the changes needed if an agent is risk averse rather than risk neutral are considered in the next subsection). Thus, the optimal fee f for a risk-neutral agent is described by:

$$f(x,z) = x - k$$

where x is the value of the outcome x and k is a constant amount kept by or transferred to the principal. The latter reflects a minimum payment to the principal to induce the latter to administer and participate in the applicable principal and agent relationship. Under this type of fee structure, the marginal fee of the agent and incentive perceived by the agent as an encouragement to invest effort that the agent believes will affect an outcome will vary directly with the increase achieved in the utility of the outcome. To encourage increased efforts in proportion to their impacts in improving the outcome of the agent's activities, the aggregate fee or reward motivating the agent should approximate the full benefit of a particular outcome, less a minimum fee to the principal.[47]

Variations in the accuracy with which the agent and principal can identify successful results will not affect the form of the optimal solution so long as errors in this regard are symmetrical and the net benefits and rewards are maximized under the same circumstances as would produce the maximum benefits in the case of perfect information.

However, differing abilities of a principal and agent to perceive successful results will affect the optimal fee schedule as this difference will lead to increased risks to one or other of these parties. Assuming that a principal can perceive a successful result with perfect accuracy and administers a fee accordingly, the relative inability of the agent to perceive the successful result adds a new component of risk to the agent's behavior. Under these circumstances, an agent may feel at risk that some results potentially qualifying for greater rewards from the principal will not be perceived by the agent as such and will not be pursued, thereby adding some increased risk of failure and forfeiture of a fee to the agent's situation. An otherwise risk neutral agent, once aware of this increase source of risk, will become the equivalent of a somewhat risk averse agent with perfect information. The nature of the fee incentives necessary to induce optimal conduct on the part of a risk adverse agent are described below.

On the other hand, where an agent (at the time of fee settlement) has a superior ability to perceive a successful result in comparison with a principal, then the agent may also perceive an increased risk of non-payment of a fee. In this combination of circumstances, the source of risk is a bit different. The agent may believe that she will attain a successful result in some task, but that the principal will fail to recognize that this result has been attained and fail to pay the relevant fee. Here the source of risk is not the failure to perceive the course of conduct that will best serve the principal, but rather a justified

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[46] The case where the agent is risk preferring is basically the inverse of the treatment of the risk averse agent. Just as a risk-averse agent may need a payment for success-promoting efforts to limit the agent's risk bearing and encourage efficient pursuit of beneficial outcomes, a risk-preferring agent may be willing to accept a more of the costs of success-promoting actions in exchange for a chance at a larger payoff upon achievement of a successful result.

[47] Steven Shavell, *Risk Sharing and Incentives in the Principal and Agent Relationship*, 10 Bell J. of Econ. 55, 64-65 (1979).

uncertainty over whether the pursuit of conduct aiding the interests of the principal will actually increase the rewards given to the agent.

In addition to different accuracy in their perceptions of desirable results, different biases of principals and agents in measurements of results may cause the conduct of an agent to diverge from that which will best serve a principal. Different biases in information measurements may arise for a number of reasons. For example, a principal may be better able to perceive increases in the desirable features of results of an activity than the agent who produces the results (perhaps because the principal is the immediate recipient of the benefits). Alternatively, an agent may be able to perceive the costs and risks of particular conduct more accurately than a principal (perhaps because the agent is carrying out the conduct and bearing associated costs and risks as he or she produces results). In either of these types of cases, increased risk to the agent will result. Either of these asymmetries will cause a principal to reward to encourage and promote conduct by an agent which the agent knows as not being the best way (in light of full information on costs and risks) to promote the best interests of the principal.

b. Risk Averse Agents

If an agent is risk averse, the agent will tend not to take optimal actions to pursue his principal's interests if the agent's incentives are tied just to the attainment of results desired by the principal. The agent's risk aversion will cause the agent to fail to pursue certain risky actions that would, on balance, be projected to promote the principal's interests, but which are rejected by the agent due to the latter's risk aversion. Hence, a simple fee structure that directly links improved rewards for an agent to increases in the value of actions to the agent's principal will not cause the agent to balance risk, projected return, and action in a way that will optimally promote the principal's interests. Instead, certain actions falling between the risk preferences of the principal and the agent will go unaddressed.

To offset this problem, the optimal fee schedule linking the interests of a risk averse agent and her principal will sometimes need to offset the agent's risk aversion and encourage the agent to undertake efforts optimally promoting the principal's interests despite the agent's concern over particular risks. Specifically, a risk averse agent must sometimes be paid a fee associated with efforts tending to support a successful result regardless of whether the efforts produce such a result.

This type of fee schedule encourages the agent to take actions that entail risks that the agent would not personally be comfortable in bearing, but that are nonetheless associated with optimal pursuit of the principal's interests. At the same time, by tying a fee to the completion of efforts promoting success, the agent encouraged to pursue those efforts. Where some or all of the rewards given an agent are linked to efforts in this way rather than to results achieved, the principal is in effect taking the risk that the efforts generating the reward will not produce any benefit to the principal. This element of risk has been shifted from the agent to the principal, thereby lessening the risks born by the agent.

The fee schedule that will produce optimal conduct on the part of a risk averse agent is a schedule that shifts a sufficient quantum or feature of risk from the agent to the principal to make the agent risk neutral as to the residual risk that the agent still bears. Where there are certain types of risks that an agent is particularly averse towards and other risks that the agent tends to be risk neutral towards, effort-link elements of a fee schedule may be tailored to shift to the principal the types of risks that the agent is most concerned about and risk averse towards. In other areas where the agent is risk neutral, successful results should remain the scaling criteria for fees paid to the agent.

Likewise, even if there is only a single dimension of risk faced by an agent and the approach to separating risks just described is not an option, then risk adjustment can still be achieved through effort-related rewards to shift risk taking by an agent to a neutral point. This can be achieved by shifting enough

risk from the agent to the principal to make the relevant agent risk neutral regarding the remaining risk he or she faces, but with no more shifting of risk as this would make the agent excessively risk preferring. Once sufficient risk of failure has been placed on the principal to make the agent risk neutral regarding further marginal risk, remaining components of fee rewards should depend solely on the attainment of successful results.

D. Using Agency Theory to Interpret Non-Contractual Agency Relationships

Most agency theory analyses address contract-based agency relationships such as the sales employee example described above.[48] However, to evaluate patent-influenced innovation, agency theory must be extended to assess the types of non-contractual innovation relationships implemented via patent rights and incentives. Given that agency theory has seldom been used to assess non-contractual relationships between principals and agents, some examples of how agency theory can be used to interpret non-contractual relationship may help to suggest how agency theory can be extended to patent-mediated relationships.

Steven Shavell has used agency theory to interpret varying allocations of incentives and risks within tort systems applying negligence or strict liability schemes of safety-promoting liability.[49] He considered the implications of tort liability incentives in creating agency relationships in situations where a firm is a potential source of accidents having adverse effects on others (such as environmental damage) and where the probability or severity of the accidents is influenced by the actions of the firm. Liability standards may encourage a firm in this situation to act as the agent of a potential victim of accidents by taking safety measures that help to protect the potential victim. Government action may encourage safety measures in these situations by imposing either negligence liability (triggered only where an acting party fails to exercise due care to prevent harmful accidents) or strict liability (imposed in every case where there is an accident). According to Shavell:

> "The choice between strict liability and negligence may be thought of as a choice of fee schedule for a principal (the government or society) and an agent (a firm). In this view, under strict liability an agent's fee (zero of there is no accident and negative otherwise) depends only on the outcome (accident losses), whereas under a negligence standard the fee depends on information about the agent's actions."[50]

Shavell concludes that, so long as an actor is risk neutral in these situations, a system of strict liability will tend to encourage the actor to take an optimal level of safety measures to protect society. However, where an actor is risk averse, a negligence standard in which liability is sometimes reduced based on the quality of efforts of the agent will sometimes be preferable to a strict liability scheme which would cause the actor to invest too much time and resources in safety promoting efforts.[51]

Similar non-contractual agency relationships arise out of government-imposed penalties for pollution. Fines for illegal pollution impose a payment or fee schedule on potential polluters that encourages them to act as agents of the public in seeking to prevent harmful pollution. Where the

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48 See text at Section III (B), *supra*.

49 Steven Shavell, *Risk Sharing and Incentives in the Principal and Agent Relationship*, 10 Bell J. of Econ. 55, 65-66 (1979).

50 *Id.* at 65.

51 *See id.*

imposition (or size) of pollution fines depends on a showing of harm to community members from pollution, the threat of pollution fines sets up a contingent penalty system in which parties engaging in harmful conduct (the pollution) are threatened with harmful consequences (the fines). This type of contingent penalty system is the inverse of the sort of contingent reward system associated with most agency relationships, but acts in the same way as a contingent reward system in causing agents to value and pursue the interests of principals. Contingent penalties in environmental laws tend to link the interests of potential pollution sources and potential victims. The fines that link the interests of these parties ensure that pollution control measures which aid the public (by reducing losses from pollution) also aid the firms (by avoiding the negative economic impacts of large fines).[52]

E. Interpreting Innovation Processes Using Agency Theory

Agency theory is a useful tool for analyzing innovation efforts because many innovation projects involve efforts by innovation agents (inventors) who design and refine inventions to serve the interests of other principals (that is, the parties who are the intended users of the inventions). Of course, sometimes innovators invent advance to serve their own interests and then they or others share the innovations with additional parties. While it would seem that these situations involve solo efforts, this would be deceiving. Agency processes still have roles in these settings. Agency processes may influence how innovations are expanded or refined as parties who develop advances to solve their own specific problems realize that their solutions have broader implications and seek to generalize their advances to serve a wider audience. These efforts to redesign and generalize an invention are driven by agency processes even if the initial design efforts that produced the root invention were individual efforts to serve personal ends.

Even in their initial innovation efforts to serve their own interests, agency forces may encourage self-interested innovators to think broadly about whether (and in what forms) their individual problems may be held by others and to tailor inventive projects from the outset to target a broader user group. If an innovator begins to appreciate that a particular innovation, if successful, will be useful to many users in addition to the innovator, the potential benefits to these further users may spur more extensive or different development efforts than if an innovator were only trying to produce an item or practice that is of use to him or his company. The needs of broader users will establish a different perspective on innovation with different inventive goals than just the objectives and needs of the inventor standing alone. Both the type and scope of design efforts that an innovator will invest in a design project may be influenced by the concerns and interests of other invention users. Attention to the interests of these other users will make the innovator an agent of the additional users, at least in part.

The agency relationships in play in these situations are especially complex because the agent must define many of the key terms and features of the agency relationship. Problem definition and technology assessment are key parts of agents' tasks in innovation processes. Principals cannot define precisely at the outset of these processes what they want agents to deliver in the form of inventions. Rather, principals (or the demands created by market forces representing the desires of principals) define functional needs and desires which establish the work content and reward structure of resulting agency relationships aimed at innovation. Part of the work of an innovator acting as an agent in this setting is to define more fully the needs of the principals and then to design means to fill these needs. Both the diagnosis and definition of needs and the creation of technology designs for needs fulfillment are important agency tasks in innovation processes. This type of diagnosis of principal needs by agents is not unique to innovation processes, however. It is a common feature of agency relationships in which expert agents serve the needs of less expert principals. For example, when a patient (the principal) goes to a

[52] *See id.* at 55 n.2.

dentist's office, the dentist (the agent) both evaluations what dental work the patient needs (a diagnosis and needs definition step) and then completes the needed work (a solution delivery step).

Framed in terms of agency relationship dynamics, many aspects of innovation processes can be interpreted and potentially improved. For example, key innovation features such as the risks allocated to innovators and innovation users and the levels of rewards needed to encourage efficient levels of innovative efforts by potential inventors can be modeled in terms of agency theory. These sorts of agency-based models are applied in the remainder of this article to reveal, formalize, and interpret various features and implications of patent impacts on innovation processes.

IV. Agency Frameworks for Evaluating Patent-Influenced Innovation

A. Factors Influencing Patent-Mediated Innovation

The formal description of agency incentives described in the previous section provides us with a structure for interpreting the incentives for innovation created by patent rewards and the factors that vary the influence of those incentives. Viewing the aggregate user set for an invention as the principal on behalf of whom a party working on the innovation is serving as an agent, the expected aggregate utility of the invention to users is:[53]

$$\text{Expected Aggregate User Utility} = \int\left(\int\left(U(x - f(x,z))dz\right)\, r(x;e)dx\right)$$

where:

U(x) = users' utility Function
e = agent's effort
z = users' observation of e
x = outcome
f(x,z) = fee paid by the users to the agent (a function of x (outcome) and z (observation of effort))
r(x|e) = probability density of x given e

The agent's perceived utility in this situation is given by:

$$\text{Expected Innovator's Utility} = \int\left(\int\left(V(f(x,z),e)q(z|x;e)dz\right)\, r(x;e)dx\right)$$

where:

V(x) = agent's utility function
q(z|x;e) = probability density of z given x and e

[53] This analysis assumes that there are no prior items or practices that address the user needs served by the new innovation. If such prior items or practices exist, then the analysis presented here should be adjusted to focus not on the total utility achieved, but rather just the net utility over and above the net utility achieved by using the preexisting technology. This is equivalent to saying that the origin from which utility is measure in the text should be adjusted to equal the starting point when the new innovation is developed and introduced. This starting point may include existing technological tools addressing the same practical problem as the new innovation, in which case the analysis here should focus on functionality improvements and increased utility from that starting point.

While these formulas do not dictate the precise utility functions that will influence specific innovation projects (which will be subject to context-specific consumer demands and product production challenges), these formulas do reveal the types of factors that will vary the impacts of patents across various situations and types of innovation projects. These formulas remind us that innovation under patent-mediation will depend upon:

1) Fee Amount Paid for Innovation Success: The greater the fee paid to an innovator for an innovation result x, the greater an innovator's motivation will generally be to create that result. This factor (represented by the dependence of the fee size factor f(x,z) on results x in the above model) means that fee structures providing greater rewards to innovators for successful innovation results (roughly corresponding to substantial innovation value delivered to innovation users) will typically produce more motivation and more intensive innovation efforts than smaller rewards for the same results;

2) Accuracy of Observations of Success: For a given innovation result x, the more accurately that x can be perceived and the intended reward for x paid, the more clear an innovator's motivation will be to create result x. This factor (reflected in the dependence of f(x,z) on observational quality z in the above model) means that where an innovator must worry about observational gaps such that desirable innovation success may be attained without the innovator being paid the normal fee for producing that result, the innovator's motivation to produce the result will be discounted and decreased accordingly. The offshoot in cases of high observational error or difficulty will tend to be a reduction in related innovation incentives and efforts;

3) Effort Costs Reducing Net Fee Value: The costs (or distastefulness) to agents of rendering various innovation efforts will influence the value of these efforts to agents and potentially reduce the net value of innovation incentives to such agents. This factor (reflected in the dependence of V(f(x,z),e) on e as well as fee size f(x,z) in the above mode) means that innovation process costs to agents (including opportunity costs) will be constant drags on innovation systems, leading to reductions in innovation settings where such costs are large. Also, since these costs are as measured by the agents who are innovators not the parties receiving the benefits of innovations, the costs limiting innovation results may not be easily perceived by innovation users leading to mysterious barriers to innovation progress;

4) Influence of Effort Variations on the Observation of Innovation Success: The extent to which different efforts by an agent can enhance the likelihood that successful innovation results will be recognized and rewarded as such will also influence the size of projected rewards perceived by agents and the scope of resulting innovation incentives. This factor (reflected in the dependence of innovation rewards on q(z|x;e) in the above model) indicates that agents may tend to choose efforts that either enhance the accurate observation of desirable innovation outcomes (perhaps by participating in related technology publicity or explanations for consumers) or may seek (if possible) to fabricate false evidence of innovation success to the extent that this will create the appearance of project success and produce rewards for that success. Provided that mechanisms to reveal and prevent such fraud are in place, generally innovators will have a stake in shaping their efforts to enhance the likelihood that innovation users will perceive the value of new innovations since this will enhance the likelihood that innovation rewards based on the user value of a new advance will be paid;

5) Probability-Weighted Aggregation of Rewards Across Innovation Observations: Since agents cannot count on a particular level of observation of their innovation results by innovation users, such agents cannot project their probable innovation rewards based on a particular observation level. Rather, these agents must estimate their likely rewards from involvement in an innovation

project across a spectrum of different observation levels and resulting reward variations. This factor estimate (reflected in the above model in the integration of probability-weighted value estimates $V(f(x,z),e)q(z|x;e)$ across all possible observation levels z) means that the most likely clarity levels in the perception of project outcomes will dominate the perceived value of innovation efforts by potential innovators. If most project outcomes are poorly perceived by potential innovation users, then many successes will probably be overlooked and large project rewards to innovators will be correspondingly rare. If most project outcomes are clearly observed and rewards can be based mostly on these clear observations, then the net projected size of innovation rewards will tend to be higher. The aggregation of the perceived value of innovation rewards across the probability of various levels of observations recognizes that different product perfection and marketing programs may translate particular innovation successes into highly different presentations and evaluations of innovation results by potential innovation users with highly different reciprocal payments of innovation rewards to the innovators involved. The integration of potential rewards across various observation levels provides agents with a means to consider the spectrum of possible observation processes and to create a single blended view of the value of innovation project involvement for an agent in light of the later spectrum of innovation observation accuracy.

6) Influence of Effort Variations on Innovation Success: The extent to which different innovation efforts by an agent can enhance the likelihood that successful innovation results will be realized will also influence the size of projected rewards perceived by agents. This factor (reflected in the dependence of innovation rewards on $r(x;e)$ in the above model) indicates that choices by agents about the scope and nature of efforts to exert in pursuit of innovation will enhance invention rewards where increased efforts (or different types of efforts) enhance the likelihood of successful innovation. If this is not the case – perhaps because an innovation project is technologically impossible no matter how much effort is invested or because the innovator in question plays a small role in a project and cannot significantly influence the outcome no matter how much effort is expended – then the innovator involved will not be incentivized to change his or her effort levels to achieve invention rewards;

7) Probability-Weighted Aggregation of Rewards Across Possible Outcomes: Potential agents contemplating participation in innovation projects will not perceive a single possible reward outcome, but rather will realize that various innovation project outcomes are possible, each with a different possible reward to the agents. However, this will not preclude a single perceived incentive for a given project – rather, the perceived reward for involvement in the project will be a probability-weighted sum of the various component rewards for different project outcomes. The likelihood of receiving any particular reward will be discounted by the fractional likelihood of getting that reward. The overall projected value to an agent of being involved in a particular project will be the sum of these probability-weighted reward estimates. Through is summing process, an agent can project the most likely net value of project involvement to him or her taking into account the full range of project outcomes that may influence the agent's rewards from the project. This aggregated reward estimate (reflected in the above model in the integration of probability-weighted value estimates $V(x)$ across all possible project outcomes x) means that the most likely project outcomes may dominate the reward values perceived by innovators. It may also mean that if innovators feel that they can significantly enhance the likelihood of project success (thereby increasing the weighting of high rewards related to project success), the agents may see significant value and attraction in being part of an innovation project; and

8) Innovator's Utility Function: The receptiveness to rewards presented and the risk preferences potentially discounting this receptiveness will dictate the net value of patent-based rewards perceived by an innovator ($V(x)$ in the above model). This means that the type of rewards valued

by an innovator (and the degree of value seen in both patent-based rewards and other rewards for alternative conduct) will influence the motivating impacts of promises of patent-based rewards and affect the resulting scope of innovation efforts.

These agency innovation factors suggest some of the patent system leavers that both individual innovation users and public policy makers can use to increase the impacts of patent-mediated innovation and the public value of resulting innovations. By varying these types of information and fee factors, patent-based processes can more clearly link perceived innovation value as seen by innovation users with corresponding patent rewards that incentivize specialized parties to pursue innovation solutions and create more useful technologies.

B. Optimal Patent-Mediated Agency Relationships Promoting Innovation

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Under the incentive and reward structure just described, optimal action to promote the interests of the user-principals will be encouraged if an incentive fee scheme f is presented to an innovating agent and the scheme is Pareto optimal in the following sense:

1) The expected aggregate utility of an advance to invention users is maximized over alternative fee schemes;
2) For a given fee structure, the innovator's utility is maximized over alternative effort levels; and
3) The innovator's utility is at least equal to or above the utility associated with alternative conduct.

Each of these three considerations deserves some further attention.

1. Implications for Innovation Users

The first of these considerations suggests that while various fee structures (as implemented by contractual payments promised by users or by rewards achieved by various versions of patent rights) are possible, fee structures that produce large user benefits leading to large aggregate user utility will generally be desirable over alternative fee schemes. Higher fees will tend to increase aggregate user utility where the fees encourage more effective innovation efforts[54] resulting in more utility per resulting product unit. Higher fees may also increase aggregate utility where the fees encourage innovators to produce designs that serve the interests of more numerous invention users (since more users will tend to realize more utility than fewer users). Where higher fees do not tend to produce more effective products (from the perspective of aggregate utility achieved), a fee scheme incorporating these fees will be undesirable. This will be true because the net utility to users (the overall aggregate utility less the higher fees paid) will be smaller than the net utility from a scheme charging lower fees but achieving similar innovation benefits for users.

Blends of fees paid for efforts and results may be needed to optimally incentivize desirable innovation efforts, particularly where the bulk of potential innovators are risk averse. As previously discussed, if agents pursuing innovation are risk averse, a fee structure directly tying increased fees to increased utility gains realized for innovation users may not produce optimal innovative efforts. Agents' risk aversion will cause them to fear to embark on certain innovation projects with significant risks of

[54] Increased fees may encourage this by either incentivizing innovators to work more on their advances to improve them to higher utility levels or causing innovators to focus more effectively on product utility in setting product design criteria and producing more useful product designs.

failure even though a risk neutral agent would pursue the same project and the relevant principal would benefit from the project. Risk averse agents will balk at certain risky types of innovation projects that exceed their limited risk preferences. In these situations, an optimal fee schedule will shift some of the risk of failure of an innovation project to the principal involved (for example, by paying innovators straight salaries for innovation efforts and further bonuses or other incremental compensation for successful efforts providing increases in benefits to innovation users.

In addition to helping to offset the risk aversion of some agents acting as innovators, a fee scheme that turns (at least in part) on efforts rather than results may be easier to implement than a scheme turning on results because the relevant efforts are easier to observe and interpret than the results. Information gathering costs may also influence choices about optimal reward criteria. To the extent that observations are imperfect (or that improved observations are highly expensive to obtain), it may be highly expensive to administer a fee payment system that accurately monitors agents' actions and only grants rewards where desired efforts are undertaken or results achieved. Measurement costs in administering innovation fees and rewards may be large enough to be their own compelling design limitation. The size of measurement costs may overshadow the advantages of gaining better information and administering innovation fees in a manner that more carefully matches success in innovation efforts or results. In these situations, lesser emphasis might be given in a fee scheme to aspects of efforts or results that are particularly difficult to monitor. For example, if the value of innovation results is difficult to measure at the time a payoff to an agent is expected (perhaps because related products are still in development or because the full range of users and user impacts of an advance are still uncertain), then a fee scheme emphasizing the completion of efforts tending to produce useful results might be preferable to a scheme in which the size of a reward for innovation turns on the usefulness of the advance to the public.

2. Implications for Agents Engaging in Innovation

Once a probable fee structure rewarding innovation is known, agents capable of completing innovation projects will tend to jockey their efforts to maximize their own returns within the spectrum of available rewards. This positioning behavior has several consequences under the proposed agency model for innovation projects.

First, agents will tend to focus primarily on efforts or results to the extent that these factors dominate the criteria for determining and increasing the agents' potential rewards. Where the primary criteria for determining the rewards for innovation to be paid to agents is the aggregate increased value of innovation results for innovation users, agents attempting innovation will have reasons to tailor their innovation designs and their measures of innovation progress to the attainment of benefits for innovation users. The overall practical value of innovation results to innovation users will be an indicator of rewards payable for successful innovation results. By contrast, rewards which are dominated by higher payments for completion of certain innovation efforts (hopefully, efforts tending to increase the chances of successful innovation) will tend to shift agents' behavior towards the completion of those efforts regardless of whether the efforts actually increase invention users' benefits from an innovation or otherwise promote the interests of innovation users.

Second, agents pursuing innovation may feel that many factors governing the success of innovation results (particularly the popular distribution and commercial success of such results) will depend on factors far beyond their control such that rewards derived only from that success and measured solely from the commercial value of innovation will entail very high risks to the innovators. In these circumstances, promised of rewards based on other factors than innovation results as measured from innovation value to users may be needed to lower innovators' perceived risks and create attractive incentives for innovation efforts. This risk lowering can be achieved by rewarding innovation efforts directly, either as a sole reward for actions supporting innovation projects (as where an employee is paid a

salary, but has no stake in the commercial success of a project) or with a combination of rewards for efforts and results (as where an employee is paid a salary for innovation efforts and promised a further bonus measured from the commercial success of project results). Such a blended set of incentives combining low-risk rewards for innovation efforts and higher-risk rewards for innovation results may be needed to motivate user-focused innovation activities by highly skilled agents who are capable of technological innovation, but who are unwilling to bear the full risk that these efforts may fail to produce useful, valuable results.

3. The Competing Lure of Alternative Activities and Rewards

The third necessary feature of an optimal innovation fee scheme is that the scheme should provide an expected net reward to an agent that is at least as large as the reward the agent can gain through alternative activities. This implies an important limitation on viable fee arrangements. Unless, an agent considering whether to embark on an innovation project can project a probable reward that is greater than the projected rewards available for other, less risky activities, then the agent will generally not pursue the innovation project. Innovation in these circumstances will be trumped by the lure of rewards from alternative activities. Because the time and talents of potential innovators are limited resources – and in the case of our best innovators, highly limited resources – this tension between innovation and potentially rewarding alternative activities is a constant threat to innovation efforts.

The background lure of alternative incentives and rewards dictates some important features of agency relationships promoting innovation. First, background labor market conditions and career alternatives for potential innovators determine what sorts of innovation arrangements and projects are attractive. Where the expected payoff of an innovation project or activity is not demonstrably greater than the pay an engineer or other innovator can obtain in more mundane but more certainly rewarding lines of work, there would seem little economic reason for the engineer to pursue the innovation project over the more certain source of income. Admittedly, other incentives (such as rewards from reputation or prestige gains following successful completion of important inventions) may encourage innovators to pursue projects where monetary rewards alone would not be sufficient to produce innovative actions. However, even these additional factors and sources of motivation may only be sufficient to overcome small gaps between projected economic rewards for high- and low-risk activities available to potential innovators. Reputation and prestige gains from research success are potentially important motivators for innovation effort, but may often still be trumped by the more certain projected economic rewards available to talented engineers and scientists by foregoing high-risk invention efforts and pursuing more certainly compensated alternatives.

Second, the lure of rewards for alternative activities means that highly capable individuals may need especially large incentives to induce them to turn towards innovation projects amidst the many highly compensated projects available to them. For the most talented members of engineering or academic elites having state-of-the-art knowledge or training that enables them to produce exceptional, non-obvious advances in their fields – the types of advances that patent laws and incentives are aimed at increasing[55] -- the background or "reserve" incentives needed to attract individuals to innovation projects may be particularly large. These rare, highly talented individuals will frequently have significant value to corporations, universities, or other employers in many capacities, providing many attractive alternatives to these individuals in private or academic employment.[56] The rewards available for these alternatives

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[55] *See* 35 U.S.C §103.

[56] By contrast, the average engineer in a particular field -- a person with widely held skills who is capable of altering or expanding past designs in the same field by applying analytic techniques that are used in day to day activities in the field of interest but who will rarely go beyond this to realize non-obvious advances –

establishes a threshold level of compensation above which innovation project incentives must rise to attract the attention of these essential individuals. Invention incentives must not only encourage invention efforts, they must trump the many attractions and types of potential compensation that highly capable (and often highly compensated) individuals will have.

C. The Model Illustrated: A Simple Agency Innovative Process

To illustrate some of the analytic strengths of the agency model of innovation and incentives just described, this section describes the agency features embedded in a simple innovation project. In this project, a single agent works on an innovation on behalf of a particular principal.[57] Assume that a particular business person A operating a retail store engaged in widget[58] sales (the principal) wishes to improve the widget containers used in his retail business. Widgets are fragile devices that are known to become inoperative unless kept in special containers that maintain carefully controlled surrounding temperature and humidity. A is dissatisfied with the widget containers currently used in his retail stores and contracts with engineer B to produce an improved widget container. The contract specifies that a successful container design must reduce spoilage levels or electrical operating costs (or both) relative to the widget containers presently used in A's retail stores.

The contract between A and B specifies that B's efforts will last for three months, at the end of which B will deliver her new container design. At that time, if she is successful in producing an improved design (as measured under the above design criteria included in the contract), B will receive a design fee. In negotiating their contract, A and B initially present two different ideas about how this fee should be determined. B wishes to receive a flat fee for each hour she spends on engineering efforts related to the contract. She is not sure that she can produce a design with the features that A is looking for, but B thinks that there is some hope of success. Since she foresees a substantial chance of failure, B is not willing to contribute her own time and effort to the project at the risk of losing these resources if she cannot produce a successful widget container design with the specified features. B, in effect, wants to put the risk of project failure on A. B points out that she has recently been employed at $50 per hour as an engineer and expects to gain at least this level of income from the present project.

A, on the other hand, hopes that the contract will provide for no payment until B produces a successful design and then only a payment that is scaled to the cost savings achieved by the new device. A proposes that B's fee equal the cost savings realized by A during a year of using widget containers

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will be more numerous and more easily drawn into innovation projects. For such an individual with widely held skills, the reserve level of rewards that must be overcome by innovation incentives to encourage innovative risk taking and participation in innovation efforts is lower than will be the case for those few innovators with exceptional, highly compensated skills. Elevated incentives -- perhaps administered through patent rights -- may need to be offered to scientists and engineers with rare, highly compensated knowledge or skills to lure these parties with "non-obvious" insights into the innovation game as agents serving potential innovation users. At the same time, equivalent incentives may not be needed to attract the more common engineers with average skills. This distinction in reward levels is currently observed within patent laws by offering patent rewards to parties producing non-obvious inventions but precluding patent rights for other new types of advances that are mere obvious extensions of previous designs in the same field.

57 *See* Stanley Baiman, *Agency Research in Managerial Accounting: A Survey*, 1 J. of Accounting Literature 154, 164-65 (1980) (presenting a similar example of a simple principal and agent relationship in the context of a product maintenance project).

58 The widgets involved here are characteristic of widgets generally. They are presumed to be hypothetical items having useful (if mysterious) qualities, the nature of which is not germane to our discussions.

based on the new design. For this year, all of the net benefit of the new design will go to B, creating strong incentives for B to pursue and increase these benefits. After the first year, all of the same benefits will go to A, providing incentives for A to pursue the project.

After some negotiation, the parties agree on a fee structure that includes both efforts-based rewards (in the form of a payment of $30 per hour for services rendered) to interest B in starting the project and a further results-based payment for successful delivery to A of a widget container meeting A's design criteria. The payment for successful project completion is set at 50 percent of the cost savings realized by A over one year of use of the widget container delivered by B (thus creating a reward for achieving desirable results for A and for increasing the scope of benefits transferred to A via a successful design). The project completion payment is to be paid a year after B delivers a widget container reflecting A's design criteria. The blended combination of efforts-based compensation and results based additions both reduces B's risk in the project and still somewhat links her incentives and innovation focus to the functional results and value desired by A.

In carrying out this contract, A and B will need to complete three monitoring steps and interpret three corresponding performance signals. First, in qualifying for her hourly fee, B will need to demonstrate reliably that she has spent the hours of work she claims on efforts related to the innovation project. Second, at the final delivery stage the design submitted by B (if any is submitted) must be measured against the criteria for success specified in the contract. Third, assuming that it is a successful design, the further cost savings realized by A must also be measured to determine the size of the reward to B that is due.

Several types of measurement problems may frustrate the administration of this agency arrangement to ensure payment of rewards to the agent in ways that will best promote the interests of the principal. Rewards for efforts should ideally be paid only for efforts that promote successful results for the principal, yet limiting reward payments to these circumstances entails two potential measurement problems: first, potential inaccuracy as A seeks to measure the scope and quality of B's efforts to modify A's old container designs and, second, even if A's efforts can be measured with perfect accuracy, potential inaccuracy in evaluating whether those efforts actually increase the likelihood of a successful project outcome. Inaccuracies in either of these types of precursors to reward payments may result in payments made for dysfunctional actions by B and inefficiencies in the innovation incentives aimed at promoting delivery of a successful design to A.

Other measurement problems and uncertainties will add inefficiencies at the point where B's delivered designs are assessed as a possible basis for payments of rewards to B for successful project completion. While the use for a year of a new widget container conforming to B's design may provide a practical measure of the probable value of the design to A, the representativeness of this measurement (or A's honest reporting of the scope of the benefits he achieves) may still be in doubt. Measurements of this benefit will probably be somewhat uncertain and B will be correspondingly uncertain about the scope of the results-based rewards she can expect. In the face of such uncertainty, B may cut back on her design efforts to a level that is below the level that would have produced more beneficial design results from A's cost/benefit perspective.

In light of these sorts of measurement problems and resulting inefficiencies, A's challenge as principal is to choose B's payment schedule and the associated monitoring steps for gauging B's efforts and results so as to maximize A's own expected utility while inducing B to act as an efficient and effective agent advancing A's interests. B's aim as an agent is to supply the type and amount of design effort that will maximize her own expected utility given the agency relationship's payment schedule and monitoring system. In determining the desirability of any payment schedule-monitoring system

combination, A, as principal, must analyze what level of innovative effort B, an agent pursuing his own best interest, is likely to supply given the incentives of the payment schedule-monitoring combination..

D. Extending the Agency Innovation Model to Multiple Agents and Multiple Principals

Innovation opportunities are often pursued simultaneously by multiple agents (in the form of competing innovators) serving multiple principals (in the form of groups of potential users of a single innovation). The involvement of multiple parties on either or both sides of principal-agent relationships for innovation may affect the formation, execution, and effectiveness of these agency relationships. The involvement of multiple parties may add a number of complicating features to agency processes supporting innovation, including enhanced transactional costs in administering these processes and expanded opportunities for strategic behavior. This subsection explores some of agency implications associated with multi-party agency relationships for innovation.

1. Implications of Parallel Innovation by Multiple Agents

Where multiple parties work in parallel to produce an advance, the nature of the additional agency process features will depend on whether the multiple agents pursue innovation in a cooperative, independent, or strategically negative manner. Each of these possibilities is considered here with attention to the impacts of these behaviors on optimal fee schemes for incentivizing the multiple agents involved.

a. Independent Agents in Competition

Where a single user would benefit from a particular innovation, the user may wish to promote competition to produce the innovation among multiple agents. For example, in the context of the container project just described, the potential innovation user A many know of two engineers B and C who appear capable of developing a new design for an improved container. A might establish a development contract with each of these parties in which the first of B or C to submit a satisfactory container would be due a fee, with the amount of the fee to be determined based on the amount of savings achieved by A as already discussed. In such an arrangement, the slower party would receive nothing. Such an arrangement would establish the counterpart to bounty arrangement in the Old West in which the first party to deliver a specified criminal to public authorities was promised a bounty payment. These types of historical bounty payments rewarded speedy and effective work since the first to bring in a criminal received a reward while others who may have been looking for the same criminal but who were slower or less effective in catching and bringing in the criminal received nothing. In the same way, a bounty contract related to innovation can place a premium on speed and effectiveness in design generation, with the first submitting a successful design qualifying for a payment and the slower or less effective designers attempting similar innovation receiving nothing.

Where multiple agents are aware of the competing efforts of other agents in a situation like this,[59] but the agents are unable to interact to form coalitions so as to cooperate in their innovation efforts, the innovation incentives seen by each agent will be discounted by the risk that their efforts will be trumped

[59] Where multiple competing agents working on an innovation project are not aware of each other, the incentives perceived by each may be very similar to those perceived by a single agent working on a similar project. However, the offering of an innovation reward under terms that indicate the reward will be paid to the first party who produces a particular result implicitly raises the possibility that there may be multiple parties pursuing this reward. The reference to first submission suggests that there may be second and subsequent submitters who will have worked on the project yet receive nothing.

by a competitor and they will receive nothing. Each of the innovators will feel some uncertainty about the progress and success of the others, adding a source of perceived risk that the individual innovator will be beaten out by a rival and will both not qualify for the reward at issue and need to bear any costs they have incurred in their unsuccessful innovation attempts. Information gained about the relative competence and progress of competing innovators will affect the size of each innovator's incentive discount due to fears of competition.

If a particular innovator has sufficient private information to believe that he need not worry much about competition by rival innovators, the discounting effect due to fear of rival innovators may be small. This may be the case, for example, if an innovator, although aware of competitors, feels that she has significant background knowledge in an application area or insights about the capability of a technology not shared by her rivals. However, if the rivals seeking innovation simultaneously are both aware of each other and consider themselves as relatively equals in the competition to produce a successful advance, the discounting effects of this awareness of competition may be considerable. A potential innovator considering an innovation project under these circumstances may significantly curtail the efforts he or she is willing to contribute to a particular project or may choose to turn away from participation in a particular project altogether in favor of pursuing alternative efforts and sources of income with more less uncertainty. Concern over competitors may also bias innovators in favor of quick innovation methods over slower but arguably more effective methods as the quick methods will be most likely to help innovators win a "race" for innovation rewards that are available only to the first producer of an innovation.

Where incentives to potential agents are somewhat weakened by fears of rivals, principals seeking innovation can somewhat overcome this problem by establishing additional fees promoting entry into innovation projects. Where the risk of losing to a rival innovator is real, each innovator may refuse to embark on an innovation project unless paid a substantial fee for their efforts. This type of payment would overcome the innovators' concerns over losing out to rivals, but would also add to the costs of innovation for the principal or the amounts that the principal can pay for results achieved in the innovation project.

b. Independent Agents Hindering Rivals

Where multiple independent agents pursue innovation in parallel and are both aware of their rivals and have opportunities to influence the activities of their rivals, the multiple agents may interact in negative ways to impede the chances of success by rivals. Particular agents may see an advantage in impeding rivals in this way if such negative actions are either undetectable or at least not penalized within the applicable reward scheme incentivizing innovation. Where the primary rewards for innovation (such as patent rights and associated commercial returns) primarily involve payment of only one fee for the first to produce a particular innovation, impeding efforts need not completely interfere with a rival's efforts, but need only slow those efforts down enough to insure that the impeding party wins the race to be the first innovator and thereby qualify for the available innovation reward. The threat of innovators' hindering efforts will reduce the prospects of success perceived by particular competing innovators, thereby reducing the net incentives to pursue innovation projects and the range of advances those projects will produce.

c. Cooperative Multi-Agent Actions

Where multiple agents can bind themselves together and jointly pursue an innovation project through coordinated actions, a number of benefits may follow and many of the potential problems of rivalrous action can be avoided. Multiple innovators working together can produce an efficient team effort in pursuit of a single innovation reward to the group (which they can agree among themselves to be

split in a pre-determined manner). The group members will not have to worry about other group members as rivals (assuming that none default from their group arrangements and commitments). The group will see the full value of an offered reward as the incentive for pursuing an innovation project. They will not need to discount the predicted value of this reward due to uncertainty about whether they are going to be beaten out by rivals (except, of course, further rivals, if any, who are not part of their innovation group).

Coordinated efforts among team members can heighten the efficiency and effectiveness of innovation efforts by avoiding duplications of efforts, realizing economies of scale, and allocating specialized tasks to team members with the best specialized knowledge and skills to perform those tasks. Some projects may require contributions by more than one innovator, either because contributions from very different fields are needed to complete the projects or because the tasks needed for completion are too numerous for one person to complete in a timely manner. Team innovation will be the only way to compete innovation projects in these sorts of circumstances. By realizing the various advantages of teamwork, multiple innovators working in a single team may produce more efficient and extensive innovation results than the same number of innovators could have realized if acting as generalists in isolation.

Of course, working in a group through cooperative action has its own costs. Innovators working in a team -- perhaps in a joint venture or a startup company -- need to define, coordinate, and combine their individual efforts to accumulate results that successfully complete an innovation project. They also need to agree upon means for allocating rewards received for successful project completion (or at least upon a mechanism for allocating such rewards if the rewards are received). The group members also need to work out the ongoing administrative details of operating as a group and communicating about partial progress and problems to other group members. These various coordination and operational tasks will add substantial administrative costs to group operations over comparable individual projects. Intra-group interactions among team members will also create opportunities for strategic behavior among group members as some individuals with the group seek to maximize their returns at the expense of other group members. The resulting administrative costs and strategic behaviors will tend to reduce the innovation incentives seen by some or all of the group members, thereby diverting them from some of their potential focus on the needs of principals in the relevant innovation projects.

2. Implications of Innovation Benefitting Multiple Users

The addition to the model of agency relationship for innovation of multiple potential users of an innovation may add considerable complexity to the formation and operation of such relationships. This type of agency relationship involves multiple principals who can either offer individual rewards for the supply of advances serving their individual needs or who can band together to establish an overall reward for an advance serving a common need. The first situation can be modeled as numerous separate agency relationships that happen to be coexisting at the same time. Since the implications of agency innovation serving single principals have already been considered, this situation involved parallel repetitions of these individual-focused relationships will not be given additional attention here.

The possibility that multiple principals may act in concert is a new circumstance not yet considered. This potential for group action on the principal side of agency relationships may add both efficiencies and problems to innovation processes. To examine the implications of adding multiple potential users to the agency innovation model, consider an extended version of the container design project already discussed. Assume that instead of just A as a single potential user for the targeted new container there are approximately 1000 retail stores with needs similar to those of A. The operators of all of these additional stores might benefit from an improved widget container design. For simplicity, assume that B is the sole innovator who seems capable of producing an improved design in an efficient,

effective manner. Although B's efforts could produce benefits for the multiple store operators, the process of bringing the store operators together to offer and administer rewards for innovation (or of finding a surrogate for these multiple operators in the form of a product developer and producer who will take the development risk on behalf of the multiple container users) can add considerable complexity to the innovation process and undercut related innovation incentives.

Free riders among the multiple store owners will be an important concern in this setting. If a particular user C thinks that efforts she funds will work to the special benefit of another rival store owner D, then C will be hesitant to fund and reward innovation efforts by B. C may be hesitant to contribute to innovation incentives if she fears that D will not bear his fraction of the overall container development costs (placing more of these costs on C and the other store operators who agree to contribute to the development project). Where C and D are in direct competition, these fears will be justified. D will be able to use the resulting container in business activities that will aid D's retail store competition with C. If D does not pay the same product development fee that C pays, D will eventually conduct business activities that leave him stronger than C. From C's perspective, this scenario will seem like putting C's money in the pocket of a rival, strengthening D over C in subsequent competition between the two. Rather than providing D with this advantage as a "free rider" who gains B's efforts without paying a share of the costs of those efforts, C might forgo involvement in the innovation project altogether. C may rightly believe that moneys she would have used to incentivize B's innovation are better used to fund business activities with a greater certainty of a profitable return to C and no benefit to D.

One way for C to avoid these sorts of free rider effects and to help justify C's investment in B's innovation efforts is by limiting access to the results of B's work to C (and others like C who pay for and incentivize B's work). Limited access might be accomplished through contractually-imposed access limitations and trade secret protections if the new widget container can be used in secret and trade secret protections retained for the features of the new design. This strategy would lessen fears of free riders and force competitors such as D to bear their own development costs if they wanted access to a similar container design. However, this type of system of parallel container development raises its own problems. First, under this scenario, multiple container users (or groups of users) will need to identify and contract with parties capable of innovation efforts, leading to duplicate transactions and waste in innovator identification, contract formation, and innovation activities. Furthermore, assuming that B is the best qualified party to design the relevant innovation and his services were reserved to the first parties who engaged him, subsequent contracting parties or groups would have to make due with lesser innovators and less effective innovation projects. Finally, a trade secret strategy may simply be an ineffective access control mechanism for a publicly disclosed product – like a product container – where the key elements of the design will be revealed through commercial activity and related public revelations. Once these revelations have occurred, there will be no trade secret protections left for the revealed design details. Other parties will be free to use these details in their own product containers, leading to the types of free rider consequences already discussed.

Putting free rider behavior aside, there are many other administrative difficulties and costs that may frustrate the formation of effective incentive contracts for innovation involving large groups of potential innovation users. To create a single contract that established innovation incentives on behalf of all users and that avoided the types of duplications of efforts just discussed, the parties seeking to create and administer an agency innovation process on behalf of numerous principals would have to overcome several hurdles. The multiple users interested in a particular type of advance would need to be identified, enter into a contract defining an agent's innovation fee and a fee sharing mechanism, specify further administrative arrangements governing the monitoring of the agent's efforts and the payment of the relevant fee upon a successful result, and further agree on a means to share ownership or control of rights and access to the resulting innovation.

While agreement on such complex terms might be possible, at some point the size and complexity of a potential user group would add such costs to the contracting process that full groups of innovation users would not participate in creating innovation incentives for potential innovators. With some users left out, the remaining users (assuming that they did band together in fractional subsets) would only create innovation incentives that reflected the needs of this partial user group, thereby establishing smaller incentives than if all the invention users' needs and related incentives where applied to the innovation project. The result will tend to be suboptimal incentives to innovating agents that encourage only those innovation efforts that are reasonable in light of the faction of users participating, but that do not encourage the broader set of innovations that would be reasonable in light of the full set of user interests potentially served by the innovations. Inefficiencies and ineffectiveness in the contracting process will tend to leave the interests of some users out of the incentive process and thereby create suboptimal innovation incentives.

The problems of innovation group contracting become even worse if it is assumed that the interests of different invention users will be somewhat disparate, such that the benefit which each party will expect from a new widget container design will be different for each potential user. In these circumstances, some users (the least benefitted by a new advance) will expect others (the most benefitted) to pay more of the total administrative and incentive costs for development of the innovation (perhaps via a contribution to these costs that is scaled to the projected benefit of the targeted advance to each user). This type of differentiation of interests -- and the many related opportunities for disagreements and frustration of contract formation and administration processes -- adds substantial further uncertainty and dysfunctionality to contractual means for promoting innovation on behalf of multiple users.

E. Patents as Substitutes for Contract-Based Incentives In Agency Innovation

By solving some of these problems with contract-based agency processes, patent rights offer streamlined means to promote innovation by multiple innovators on behalf of multiple potential innovation users. Patent rights provide means for overcoming the problems of group action for both principals and agents in innovation projects.

For principals (that is, potential invention users), patent rights create incentives for innovators to organize and take risks on product development on behalf of groups of potential invention users. These risk-taking innovators are often companies given the necessary resources and scale of activities needed to conduct many modern forms of technological research. Corporate innovators serve as stand-ins for the interests of multiple users, taking innovation risks cabined (at least in part) by confidence based on patent rights that if the companies are successful in producing new products desired by users, the users will need to come to the companies for the resulting products and that the costs of development and a further profit compensating for risk taking will paid from product sales. The need for contracting in advance with users is superseded by the patent-guaranteed promise of exclusive domains of commerce in a patented advance. Corporate innovators can focus on risk taking and capital generation concerning technology capabilities and risks of technological project failure without worrying about the further risks of free riders and other compensation gaps upon production of technologically successful designs. Innovation companies accept the risks of innovation development and avoid the need for costly group contract formation. They also preclude free rider holdouts among invention users by demanding that all users pay patent-influenced prices if they want access to patent protected products.

For agents (inventors), patent rights create value in their research results that they can not only convey to others, but that varies in amount based on the full scope of benefits of successful inventions to their complete set of users (at least in the geographies and time frames of patent control). This valuation scaling reflects both the value of a patented advance to each user and the number of benefitted users. A patented invention creating an average of $1000 of incremental value for each user over prior products

lacking the patented feature is more valuable than a patented invention with $100 of incremental value, all other things being equal. And a patented invention with $1000 of incremental value to 1,000,000 likely users is more valuable than a patented invention with $1000 of incremental value to only 1,000 likely users, all other things being equal. Inventors can project these features of future value and target their innovation efforts accordingly.

This projection of value will have differential effects on both the invention targeting and invention perfection efforts of potential innovators. This value scaling will encourage inventors to diagnose the needs of users to serve the largest individual needs possible and the largest numbers of potential users as possible. It will also encourage them to shape their actual innovation efforts and designs to serve the largest aggregate value to users. By thinking in this way, innovators are incentivized by patent rights to identify and then pursue the aggregate interests of potential users of patented advances. In this way, patent rights have the potential to create the equivalent of contract-based invention incentives, taking into account both individual users benefits and overall user numbers, without the need for costly contract formation and administration processes.

V. Patent Law Through an Agency Theory Lens

By examining the impact of patents in shaping agency relationships for innovation, we can identify a number of previously unappreciated influences and functions of patent rights. Patent standards and policies of several types deserve further study and possible reforms in light of their agency roles. This section identifies some of the patent issues that may bear new study when seen from an agency perspective. The series of patent law issues addressed here does not exhaust the range of patent questions that may be profitably reevaluated via an agency lens, but does suggest the power and value of agency evaluations of patents across a wide range of patent standards and practices.

A. The Outer Boundary of Patent Rights: Desirable Limits of Patentable Subject Matter Under an Agency Model

1. When Should Patent Rights and Rewards Substitute for Contract Terms as Innovation Incentives?

Patentable subject matter standards establish the outer boundaries of the patent system and associated administrative processes.[60] Types of innovations that do not constitute patentable subject are simply outside the patent system and related rewards, controls, administrative processes, and enforcement costs. Hence, patentable subject matter standards provide means to tailor the patent system to situations where the special incentives of that system are needed, while excluding the system from situations where the net costs of the patent system are high.

Viewed as a substitute for contractual processes in creating desirable agency relationships for innovation, the proper scope of the patent system can be evaluated as a response to contract failure. Under this view, patent rights are substitutes for contract rights in situations where contract processes are likely to fail and consequently unlikely to form desirable agency relationships for pursuing innovation projects. The desirable scope of the patent system – and the proper scope of patentable subject matter – is dictated by likely contract failure. Patent rights are desirable where they are needed as a contract substitute in forming agency relationships for innovation. Conversely, where contracting for innovation

[60] Advances that meet other patent law standards are only proper targets of patent protections if they entail patentable subject matters. *See* 35 U.S.C. § 101. Thus, the subject matter tests within patent law are effectively "gate keeper" standards determining where the patent system will have any traction and effect.

is likely to be effective in serving the needs of all likely users of an innovation, then the administrative costs (and potential intimidating effects) of the patent system probably serve no incremental purposes and should probably be avoided. This section develops an account of patentable subject matter standards from this agency perspective, showing how agency analyses establish a normative case for specific patentable subject matter standards (or at least portions of such standards).

Viewing patent rights as useful substitutes for contract-based agency innovation processes, these substitutes may be particularly valuable in at least three circumstances. First, patent rights may be needed as contract substitutes for innovations that are likely to be of interest to large numbers of potential users. Second, patent rights may be needed as contract substitutes for innovations that are of interest to only a few users, but that are within the capabilities of only a narrow number of innovators who are difficult to identify and contractually influence. Third, patent rights may be needed as contract substitutes for innovations depend on new technologies with functional attributes that are largely unknown to potential users such that these users will be unlikely to contract with specialists in those technologies as means to serve the users' functional needs. This section considers each of these settings where patent rights may be of particular value in adding meaningful inducements for desirable innovation.

2. Innovations Foreseeably Capable of Productive Use By Numerous Parties

Patent rights will tend to be useful substitutes for contract-based innovation incentives where innovations appear likely to serve numerous users. Contract substitutes will be needed in this context because innovation contracts incentivizing agents to advance the full aggregate interests of the relevant users will be difficult to form due to the large number of relevant users. Where an innovation is likely to be broadly useful to numerous users, the binding together of the relevant user group thorough contracting processes will be particularly burdensome due to the difficulty of identifying and negotiating contract terms with most or all of the substantial number of parties involved. Without full participation of the interested parties in innovation contracts providing promised rewards to innovation producers, such contracts will only reflect the lesser interests and incentives provided by the subset of users within the contractual arrangements. These incentives will be suboptimal because they are not based on the full set of interests and potential invention benefits for all the invention users. The difficulty in forming contracts among the user set will ensure that only some of the relevant users are involved, which will in turn ensure that only some of the relevant incentives for innovation are provided to agents considering and pursuing innovation projects.

Rather than relying on contractual processes, rewards created by the enforcement of patent rights can establish potential rewards that reflect the aggregate utility of an advance to the full set of its potential users. The full set of users can be charged for the resulting innovation because all users will be precluded by patent rights from uncompensated access to the inventions. The charges paid by this full set of users can pay for innovation incentives that reflect the full number and extent of user interests served by successful inventions. These sorts of desirable invention incentives for agents pursuing innovation can be created through patent rights while avoiding the contract formation costs and free rider effects associated with private contracting processes aimed at encouraging innovative efforts by agents.[61]

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[61] I have previously argued that these considerations regarding the limits of contractually-initiated innovation indicate that certain advances in computer implemented information processing methods should be recognized as patentable subject matter. In particular, my analysis suggests that information processing advances that are capable of description in a manner that can be transferred to multiple users and that are of use to a substantial number of users should be treated as patentable subject matter. *See* Richard Gruner, *Intangible Inventions: Patentable Subject Matter for an Information Age*, 35 Loyola L.A. L. Rev. 355, 449-450 (2002).

3. Innovations By Hard to Find Innovators

A second class of innovations that are also poor targets for contract-based innovation (and correspondingly good targets for patent-based substitutes) includes innovations capable of production only by innovators who will be hard for users to identify in advance of innovation efforts. The difficulty in identifying candidates for producing particular types of innovations may stem from the rarity of individuals having the necessary skills or knowledge to produce the needed innovation, the lack of public revelation of the full extent of the innovators' knowledge or skills, the unfamiliarity of the innovators' work to the relevant users because that work is performed in a field having little contact with the user group, or the lack of special features distinguishing innovators from large numbers of similarly situated parties such that the innovators are lost in the crowd of similar parties. In these and other circumstances, difficulties in finding relevant innovators will impede the formation contract-based relationships for innovation. If interested users cannot find the relevant agents capable of serving the users' interests, they cannot form contracts incentivizing innovation by the agents. Hence, difficulties in identifying innovators establish weaknesses in contract-based processes for innovation, which creates corresponding needs for patent-based incentives.

Difficulties in identifying relevant innovators may be quite common and lead to frequent gaps in contracting processes. Search costs for relevant innovators may be large and neither set of interested parties -- the potential users of a new advance and the parties with sufficient skill to develop the advance -- may have a sufficient stake in the outcome to invest the search costs needed to find each other. Search costs may be particularly high in the early stages of the development of a new technology or engineering approach because the parties with knowledge and skills regarding the technology or design approach will be poorly known. Also, in the early development of a new technology or engineering approach, the individuals who have exceptional knowledge in the relevant discipline may be few in number. Even if a few of these parties are publicly known in the early development of a technology, they may also be contractually obligated to projects in the relevant field, leaving only other, harder to find parties as candidates for additional innovation design projects.

For example, if computer chip makers have difficulty with a particular chip cleaning problem, these specialized manufacturers may have little reason to look for a solution in the food canning industry where a similar cleaning problem had recently been solved and even less ability to identify the leading experts in the food canning solution. Even if the chip makers were aware of some parallel cleaning concerns and technology applications in the chip manufacturing and can cleaning contexts, persons in the chip making field might have little way to monitor when persons in the can cleaning field reached insights into cleaning processes that might be used in chip making. The chip manufacturers might also have few insights into who to contact within the food canning industry for design help in developing a new chip cleaning technology. Hence, it is unlikely that the chip makers would pre-identify and establish innovation contracts to incentivize parties in canning company to act as agents of the chip manufacturing concerns in the development (or modification) of can cleaning technologies in ways that were peculiarly interesting and beneficial to the chip manufacturers.

The barriers to innovation in these settings stem from transaction costs limiting successful agent identification and related contract formation. Anticipating what type of innovator to look for, identifying an innovator with sufficient ability to produce a cross-field advance, and then concluding an innovation contract with that innovator on terms agreeable to both the innovator and the relevant innovation user are all steps with significant transactional difficulties and costs. Companies seeking innovation will not want to add these costs to the costs of actually completing innovation projects and will tend to forego this type of multi-field search for innovators in favor of innovation attempts within their company or industry. As a consequence, it is unlikely that the parties will form incentivizing contracts linking the interests and perspectives of innovators in the canning industry to those in the chip manufacturing. Without this type

of contract (or some other source of cross-industry incentives) parties in the canning company will retain their limited perspective on the potential value of their new technology and will not seek to extend or clarify the value of that technology as for applications in the chip manufacturing domain. Experts in the canning industry will limit their perspective and technology-development project scope because there are no contractual incentives to take a broader view and pursue broader goals. They have not been incentivized to serve the full set of potential users of their advance.

Patent rights offer means to overcome this incentive gap. Non-contractual rights and sources of invention rewards arising from patent rights encourage innovators to pursue value in new fields and formulate their advances as broadly as patent rights and associated rewards will sweep. This perspective setting feature of patent rights operates without the need for pre-existing identification of the relevant innovators and innovation users. Nor does it require the formation of contracts between the parties. Rather, the promise of patent rights encourages innovators to look broadly for value and to consider the interests of as many users as possible from the outset of an innovation project, with the actual identification and charging of innovation users deferred to a later point when an actual advance is in hand and patent rights for that advance can be enforced.

Patent rights encourage innovators and innovation users to find each other and establish associated agency payoff arrangements. Patent rights do this through two processes.

First, by encouraging parties who are knowledgeable about new technologies to adopt broad perspectives in looking for applications and commercial opportunities for the technologies, patent rights encourage parties working on the design, refinement, and implementation of advances that serve the broadest set of potential users and largest aggregate value to users (since this will tend to produce the largest patent-mediated rewards for innovators). This perspective setting encouraging attention to aggregate user needs will influence both the designs of new applications of technologies and the size of efforts by innovators to realize applications. Application design projects with the potential to serve large user sets and achieve significant aggregate value for those users will justify the largest application design and development efforts. Patent rights exert desirable influences over the design and refinement of technology applications because design projects are incentivized from the outset towards tailoring in light of the viewpoints and interests of invention users. Agency relationships for innovation are established from the bottom up by patent incentives because the potential for patent enforcement and related commercial returns encourages innovators to look at their work with the eyes and design goals of all the potential users of their inventions.

Second, patents (or, at even earlier stages, the publication of patent applications) reveal new technologies to the public in relatively completely described forms, thereby providing means for potential users of advances based on the new technologies to identify the new technologies as potential bases for new applications. This will help other parties in the same field as the inventor to understand the new advance (and either work with it under a license from the patent holder or work around it through the creation of new designs that do not include the patented advance and, hence, do not infringe the related patent). The public description of the new technology will also help users in fields not initially considered by the original innovators to understand the patented advance and to consider whether the advance may also have value in these further users' fields. Through this response to publicity for the new technology (or even its availability in computer searching processes), a patented technology transfer process can be driven by the needs and actions of innovation users (or technologists acting on behalf of those users). Principals (that is, potential innovation users) in diverse fields can seek out agents who have already developed the germ of a potentially useful advance and license the patent rights to use the advance in additional fields and various products or services far beyond those contemplated by the original technology innovator. The original innovators will have strong incentives to cooperate with these efforts by granting the licenses and aiding parties in the additional fields since this will expand the

applications and potential patent-mediated rewards available to the innovators. The initial innovators will have patent-generated economic motivation to serve as agents of the innovation users in the additional fields because this will expand patent rewards. Here, patent rights and associated downstream licenses establish links after the initial development of a patented invention that cause the original inventors to serve thereafter as agents of innovation users in aiding the development and commercialization of diversely-focused products and services incorporating the patented advance.

4. Innovations with Initially Concealed Value

Information gaps hindering the perception of innovation value by both innovators and potential innovation users may also impeded the formation of contracts incentivizing innovation. If potential users are unable to see any advantages from a particular type of technology (and innovators are unable to convince the users of this value), the users are unlikely to bear the costs of incentive contracts encouraging agents to develop the technology. Without evidence of the value of a new technology, users funding agents to develop the technology would feel that they were throwing their money away on apparently unproductive tasks. Hence, factors concealing the value of a projected new technology are also likely to stop the formation of agency relationships promoting the development of that technology.

The new and often highly unfamiliar nature of a new technology may easily conceal its value. Where – as will be the case with many of the non-obvious advances qualifying for patent rights -- an innovation comes from outside the normal technology development channels in an industry, the parties producing the innovation may have far more understanding of the operation and functional characteristics of the innovation than any other parties in the same field. Potential users of products and services incorporating the new technology – who may not even understand technologies underlying long-standing products and services in their field – may frequently lack basic information needed to gauge the functional impacts and value of the new technology. Their lack of information about innovation value may cause users to forgo contracts for further development of the new technology even though such contracts would provide gains to the users and be attractive to them under conditions of perfect information.

Patents can provide incentives for innovators to overcome these information gaps and demonstrate to users the value of patented advances. Under the incentives created by patent rights, innovators can count on patent-mediated rewards which will tend to be in amounts that track the perceived value in the hands of users. The more users see and embrace the value of a new advance and seek products and services incorporating the advance, the more a patent holder stands to gain in patent-mediated sales prices or licensing royalties. This is the case because patent rights will force consumers who which to gain access to the new technology and realize its potential value will only be able to get the technology from sources authorized by the patent holder. The patent holder will be confident of gains from user understanding of the value of a new technology and will take the steps needed to expand that understanding. In this way, the rewards promised by patent rights will make patent holders the promoters of their own inventions, with an emphasis on establishing and publicizing the practical value of the invention to as many parties as possible. Patent rights will help to encourage innovators to bridge the information gaps that would otherwise stall the formation of incentive contracts for innovation and impede the development of potentially valuable new technologies.

Patent rights incentivize innovators to conduct searches into uses for a new technology without the need for the formation of contracts before those uses are established in the eyes of potential users. Patent rights ensure that innovating agents are offered rewards that relate to the full ultimate value of advances to users (at least during the term of the patent rights), but rewards do not depend on any particular user or users appreciating the value of the advances at the stage when agency contracts seeking innovation would need to be concluded. Rather, the patent system defers the point of fee settlement for

an innovating agent -- that is, the determination of the proper amount of payment to the agent for a successful innovation -- to a point when innovation users have much more information about the impact of the innovation and the full benefit that should be the basis for the fee to the innovator. Patent rights encourage innovators to rely on their own superior information about a technology in its early stages of development, not only about the engineering aspects and chances for technical success of their projected innovations, but also their conclusions about the probable value of innovations to the full range of users who are ultimately likely to perceive and realize benefits from the innovations.

B. Timing and Content of Patent Application Disclosures

Another feature of patent law that may bear reexamination from an agency standpoint is proper scope and timing of pre-issuance patent disclosures. Through an agency lens, these disclosures are means to either enhance the work of agents promoting innovation or to cut off duplicative and wasteful efforts of multiple agents who are working in parallel on similar innovation projects. Disclosures through the publication of patent applications can cut off potentially duplicative and wasteful parallel innovation efforts by multiple agents who are seeking (or may be about to start seeking) to fill a single type of user need and thereby receive a corresponding reward. By modeling parallel innovation efforts as instances of competition between agents seeking a single payoff from a group of principals, disclosures in patent applications can be treated as signals from one disclosing competitor to others about the state and direction of the disclosing party's work. Such a signal can cause other innovators pursuing parallel innovation efforts to make one of several responsive actions: 1) ceasing their similar efforts (because the efforts will duplicate those already completed by the party filing the patent application), 2) redirecting their efforts to ensure that they are pursuing a substantially different engineering approach which will not compete with the already developed and disclosed approach (and which may be able to qualify for its own patent protections in addition to whatever patent rights result from the published patent application), or 3) gaining new confidence that they are already on a second, fundamentally track from the advance in the published patent application, thereby reducing their perceived risk since at least one potential competitor (the party revealed via the published application to have taken a different track) will now no longer be seen as a viable threat for earlier and patent-blocking development of the second technology.

All of these responses will reduce waste due to unproductive efforts and tend to increase the range of new technologies considered in the relevant field. The researchers involved -- those receiving a signal or "technological status report" on the efforts of a competing innovator via a published patent application -- will gain the most if they receive this sort of signal as early as possible. The earlier that it is apparent that another party has succeeded in producing some new technological development, the more duplicative research that can be avoided and the earlier and more completely fears of superseding innovation development can be prevented. Hence, an agency model of patent law suggests that the earliest possible public disclosures of patentable advances is desirable, not for the consumer protection reasons related to "submarine patents" that are often cited as the basis for pre-issuance publication of patent applications, but rather because the earliest possible disclosures promote desirable signaling to competing innovators. This signaling at the earliest possible points also supports prompt rechanneling and reassurance of additional innovation by competitors of the disclosing innovators. Early signaling regarding the nature and success of innovation attempts should also support diversification of the innovation approaches carried out through agency relationships aimed at fulfillment of a single type of user need.

The contents of invention disclosures that are desirable in a published patent application can also be evaluated from an agency perspective by considering the impact of various types of disclosures on the efforts of researchers competing with the disclosing party. Present patent laws require disclosures in patent applications of information needed to recreate or "enable" use of the disclosed technology. Patent applicants are required to provide other engineers in the relevant field of an advance with enough

information to recreate and implement the patented invention.[62] This type of disclosure aids in transferring patented advances to the public at the end of a patent term (when all parties should be able to use the advance without constraint). However, an enabling disclosure alone may not maximize the potential impact of a published patent application in cutting off wasteful and duplicative research. More effective disclosures aimed at avoiding waste in competing agency processes for innovation might better serve the public.

If required disclosures in a published patent application are viewed as means to prevent wasteful duplication of innovation efforts, a different range of disclosures than is currently required may be advisable. Disclosure requirements might be reshaped to better signal fruitless lines of inquiry to other competing innovators. In addition to providing enabling disclosures for the benefit of potential invention users, applicants might be required to describe a complete history of their innovation efforts leading to the conception and reduction to practice of their claimed invention. Such as research history would signal to other innovators both the applicant's failures and partial successes in innovation efforts. Such helpful disclosures about engineering progress and "dry holes", given to the engineering community and the public in exchange for the patent rights being sought in a patent application, might be desirable means to increase the impact of published patent applications in preventing duplicative agency processes for innovation and in directing subsequent innovation efforts by agents towards still promising yet unexplored technological directions.

C. Interpreting Non-Obviousness Standards

Unites States patent laws limit patents to new advances that are non-obvious in light of pre-existing, publicly available products, services, and technical knowledge.[63] Non-obvious inventions meeting standards are unlikely to be made by the bulk of innovators in a given field. A non-obvious advance is one that a well-informed specialist having average skill in the relevant field would be unlikely to produce. Typically, these non-obvious and patentable advances will be within the range of only well-informed parties of greater-than-average skill in the relevant technological field. However, the number of innovators having greater skills or knowledge than the average innovator may be relatively few. Hence, non-obviousness tests effectively restrict patents to advances that are only within the capabilities of a relatively rare set of innovators in a field – those capable of advances requiring greater-than-average skills or knowledge.

An agency view of patent law provides an explanation of why this type of special focus on inventions by rare innovators is important. Where only relatively few innovators are potential candidates to produce particular types of advances, contracting processes to find and engage those few innovators in agency relationships to produce these advances may be difficult to carry out. Contract-based incentives for innovation (at least with respect to non-obvious forms of advances) will be correspondingly rare or, if present at all, diminished in value by the high cost of the contracting processes. A non-contractual incentive setting mechanism such as that resulting from patent rights is particularly valuable in these sorts of settings where contracting is difficult due to the rarity of the capable innovators. Non-obviousness tests focus patent rights on the settings involving rare innovators where non-contractual innovation incentives are specially needed. These same standards withhold patents and associated patent enforcement costs for advance that are within the capabilities of numerous innovators and for which contractual arrangements motivating related innovation efforts are more likely to be easily concluded.

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62 *See* 35 U.S.C. § 112.

63 *See* 35 U.S.C. § 103.

Patent incentives will be superior to contract-based incentives for activating development of non-obvious advances not only because patents avoid the need for contract formation, but also because the patents help to ensure that the full range of innovation users are compelled to contribute to innovation rewards through patent-mediated sales prices and licensing royalties. Patent enforcement compelling all users of patented advances to contribute produces greater innovation incentives than might be paid by a few contractually-bound users sponsoring innovation. Patents tend to ensure that the full range of innovation users can be called upon to pay for access to the advances during the life of particular patents. This will tend to ensure that perceived patent rewards increase with the full value of advances to all potential users. Promised rewards at these high levels will be important for non-obvious advances because the rarity of the parties capable of producing these advances means that they will often have many possible choices about activities to pursue and many competing offers of compensation luring them from the production of new inventions. To trump these competing callings and induce a party with rare skills or knowledge to address an important advance, the party may need to be offered highly substantial rewards. Patent-dictated fees based on the payment capabilities and interests of the full set of potential users of the resulting advances are desirable means to increase promised innovation rewards to the necessary levels.

D. Achieving Blended Rewards for Patent-Influenced Innovation

Agency interpretations also allow us to consider the impacts on innovation motivation of complex incentive schemes offered to innovators. The advantages of separately allocating innovation risks and incentives can be expressly modeled through an agency approach. In addition to examining the mixture of efforts-based and results-based incentives that can be offered to innovators under a patent-framed reward system, we can evaluate the advantages of establishing separate risk allocation arrangements at several levels of multi-level agency processes for innovation. In particular, using agency analyses we can appreciate the advantages of the risk allocations achieved by involving corporations (who are relatively risk neutral actors) as the primary agents searching for new innovations serving users, with the further involvement in direct innovation activities at a lower sub-agent level of individual employee-researchers (who are generally risk averse actors).

1. Multi-Level Agency Processes Implemented via Corporate Innovation

The promise of patent rights and returns for corporations whose employees produce useful advances may both encourage risk neutral innovation efforts by corporate entities and accommodate the risk aversion of the employees who innovate on behalf of the corporations. Corporations will typically have much larger resource pools to allocate to research than individual innovators, leading the corporations to be much less concerned about resource exhaustion as a result of failed projects than would individuals pursuing the same projects. The resulting risk neutrality of the corporate actors will allow them to support innovation projects with an even hand – that is, to see projects as cost-effective and desirable or undesirable with a neutral view of the risks of failure and return associated with the projects. Risk neutrality will tend to aid in the alignment of corporate commercial interests with measures of aggregate value of advances to innovation users. As such, risk neutral corporations may be better project initiators than relatively more fearful and risk averse individual innovators. Risk averse corporations will tend to support and initiate some innovation projects that are in the public interest (given their projected costs, benefits, and risks of failure), but which are not attractive to risk averse individuals who must worry about the personally devastating consequences of innovation project failure and the individuals' loss of income and basic assets.

In addition, corporate innovators may be better at targeting the initiation of innovation projects because they are working with different targeting information than individual innovators. Based on both their accumulated information about customers and their further experience with similar innovation

projects, companies can sometimes use their insights to see both more of the advantages (in user value and commercial potential) and disadvantages (in technological failure and innovation process challenges) of potential innovation projects. Because they are able to approach innovation projects with relative risk neutrality and accumulated information about innovation processes and consumer needs and desires, corporations acting as innovation agents -- or at least as primary agents much like general contractors in construction projects – can play important roles in advancing innovation projects. Acting at their full potential, corporate innovators can be superior to individual actors in selecting innovation projects on behalf of potential users, as well as in generating the financing and coordinated resources needed for large scale innovation projects.

Corporations may serve several valuable functions as primary agents standing between innovation users and individual innovators. Past experience with users can help companies to build up information about users' likely needs and reactions to future product designs. This information will aid in defining innovation goals for projects by agents working in favor of the interests of innovation users. Furthermore, parties within corporate marketing departments may be able to estimate the size of various product sales opportunities (including estimates of both sales volumes and potential product pricing) to combine spectrums of product demand to identify weighted estimates of the most strongly desired products. These estimates can be translated into engineering priorities for product or technology development and funding personnel. Along parallel lines, product manufacturing and distribution specialists may be able to contribute estimates of product production and sales difficulties that will diminish the desirability of projected types of products, thereby shifting product development priorities away from such products.

In these functions, corporate specialists other than technology specialists are acting as user agents to organize and prioritize the actions of their companies along the lines that will best serve perceived needs of product users. The specialists both project user needs and estimate the abilities of their company to meet those needs. From these estimates, they can generate some rough corporate priorities for future technology development. These corporate activities constitute agency actions that focus and advance technology development steps on behalf of potential customers. The result is technology development that more closely tailors the activities of the companies as innovators to the agency interests of the targeted technology users. Patents enhance these agency processes by framing the consumer demand and related commercial potential for technologies considered by companies, providing reassurances that the companies can look to the full extent of a patent-controlled consumer demand for a new technology as a payoff for developing that technology. Patent rights (and the exclusive commercial opportunities maintainable by enforcement of the rights) will reassure company executives that, if their company can produce products with distinctively new, patentable features of value, the company can count on gaining the full commercial return on those new features for the life of the applicable patents.

2. Blended Incentives to Accommodate Individual Risk Aversion

Agency analyses also suggest how individual-level incentives should be structured once a technology development project is initiated. Some mixture of rewards for technology development efforts (involving relatively low risks of non-payment to the individual innovators) and further rewards for technology development results (involving higher risks of technology or project failure) may be needed to accommodate the risk aversion of individual innovators. In practical terms, this means that the risk aversion of individual innovators may be best accommodated by incentivizing them to pursue innovation via a promised mix of salary payments and further bonus or profit sharing payments upon successful project completion. Risk aversion may also make individual innovators concerned about their own limited resources to be poor decision makers about targeting innovation since they will tend to shy away from some risky projects that are too risky for the risk averse individual innovators yet commercially advantageous (and publically beneficial) if looked at from a risk neutral viewpoint.

By splitting corporate, risk-neutral innovation targeting and invention returns from individual, risk averse incentives for pursuing innovation tasks, both the targeting and motivational problems stemming from the risk aversion of many individual innovators can be solved. The compensation and innovation incentives provided to company employees as sub-agents of innovation users (with their corporate employers as the primary agents) can be structured in many ways, with the dual aims of matching the risk preferences of the employees and encouraging them to undertake the actions desired by their companies. Matching the risk preferences of employees will usually entail accommodating the risk aversion of these individuals regarding the potential loss of all or most of their income due to a failed innovation project. Combinations of incentives for innovation efforts and results can be built into employee compensation schemes without exposing the employees to the full risks of innovation failure. Specifically, a combination of rewards for efforts (such as low-risk salary rewards granted to employees upon completion of assigned tasks) and rewards for results (such as higher-risk bonuses for production of patented inventions or even larger but riskier bonuses based on the commercial success of inventions) may be the best way to incentivize innovation efforts while accommodating individual risk aversion tastes.

Companies standing between product users and individual innovators provide a useful risk adjustment buffer by both taking innovation risks in a risk neutral manner while passing on risk averse incentives to individual employees undertaking innovation projects. Corporate innovators attempt to translate the demand of potential product users into product development goals and projects with related innovation incentives for individual innovators acting as technology and product developers. A corporate employer can create employee incentives representing and reflecting the commercial interests of product users to the company's employees. The company can achieve this by providing compensation to innovators that encourages innovative efforts with a focus and to a level that is efficient in light of the projected utility gains to the full set of users of the targeted technologies and products. At the same time, by providing blended combinations of efforts-based and results-based incentive compensation, corporate employer can present blended compensation terms to innovators that offset the innovators' risk aversion and encourage optimal efforts by the individuals to pursue advances serving numerous users.

These sorts of blended incentives to individual innovators can be provided through various types of corporate employment compensation, attracting many individual to innovation projects who might otherwise shy away from such efforts due to risk aversion. Individual innovators who choose to work for corporations or other organizations typically give up large project failure risks in favor of relatively stable income and lifestyles. If they choose to work for corporations as employees, innovators must typically give up (that is, assign) their patent rights to their corporate employers. In exchange, the employees receive a salary for their innovation services. However, many corporations also provide employees with results-based bonuses that turn on innovation success (sometimes scaled to the revenues generated by a successful invention). In both the amount of their flat compensation for innovation efforts and in the degree of results-oriented bonus compensation added to the flat fee, companies relying on projected patent rights can provide compensation levels to employee-innovators that vary with the full commercial value of anticipated products across broad user groups. The scope of exclusivity promised by patents ensures that the full commercial value of a patented advance can be captured and parallel, full-value influenced incentives passed on to employees completing innovation projects.

3. Blended Innovation Incentives in Universities

Universities can also blend compensation schemes for academic innovators to help ensure that these innovator focus on the needs of innovation users and the aggregate value to users of potential advances. In academic settings, however, the reward types (and hence the reward mixes) that will be the best motivators will vary from the packages used in corporate settings. In particular, the best efforts-

based rewards for academics may be somewhat different than those for corporate employees. In addition to providing salaries to academics for research work related in part to the completion of patentable inventions, universities can provide academic innovators with further non-monetary compensation by supplying stimulating intellectual environments and reputational rewards corresponding to academic positions and activities. On top of these rewards for innovation efforts, universities can provide academics with further results-based incentives such as portion of the royalties resulting from patentable inventions. More substantial results-based rewards to individual academics may flow from university policies allowing flexible leaves of absence to academic innovators which permit the innovators to join startup companies and share in the commercial value of their discoveries as co-owners of these firms. Through these types of opportunities, academics are given the chance by their university employers to realize gains from the work of the individual academics in amounts that are scaled to the full user functionality and commercial potential of the academics' patented inventions. Working in a university environment creates incentives for innovators to serve as agents of product users, with the features of the incentives tailored to the preferences of academics through combinations of efforts-based compensation (through salary and environmental perks) and additional compensation tied to commercially results of innovation projects. Such a combination of blended incentives permits universities to match the particular risk and incentive preferences of academic innovators and to encourage innovation by these parties aimed at producing inventions of use and value to broad segments of the public.

VII. Conclusion

By examining patent rights and related innovation processes from an agency perspective, the role of these rights in encouraging innovation efforts on behalf of the public can better be understood. This understanding can expand our descriptive understanding of patent impacts in many ways. In particular, patent analyses within an agency framework can directly illuminate the risk allocations and informational disparities surrounding patent-influenced innovative processes.

Agency analyses can also expand our normative evaluations of the patent system. The normative implications of patent rights can be modeled by viewing these rights as sometimes valuable alternatives to contract-based rewards in establishing and incentivizing agency processes for innovation and for adjusting innovation risks and informational disparities between innovation producers and users. Patent rights -- in combination with related institutional contracting arrangements such as employment contracts in corporate and university settings -- can create innovation incentives for potential innovators that tailor incentives to the aggregate user value and demand for new advances. In some settings, this tailoring to user demand and value assessments can be achieved more effectively via patent rights than direct contracting with users will allow. Patent system scope should extend to those contexts where patent-based incentives for innovation appear more likely to reflect full user demand than comparable contracting processes. Consequently, the scope of our patent system should depend, at least in part, on assessments of where private contracting for needed innovations is likely to be ineffective and where further, patent-enhanced rewards can therefore serve a valuable function as contract substitutes in forming and administering agency processes for innovation.

Where contracting processes are particularly unlikely to succeed in producing innovations -- as, for example, with non-obvious innovations that can be produced by relatively few and difficult to identify researchers -- patent incentives may be the only practical way to encourage innovators to adopt public-oriented perspectives on innovation goals along particularly risky paths of technology advancement. By focusing strong, aggregate demand influenced patent rewards on the achievement of non-obvious technological advances, patents encourage potential innovators to prioritize and pursue non-obvious technological advances in light of how these advances that will serve aggregate pubic needs. These strong and substantial rewards encourage innovators with unusual skills and knowledge to significantly depart from prior learning in intellectually risky manners to develop previously non-obvious advances,

and, with their occasional successes, to materially broaden the range of useful technological tools applied for public benefit. In this way, patent rights and the public-serving agency processes they further are critically important features of modern innovation, providing essential and highly valuable links between private innovation incentives and public benefits from expanding types of successful inventions.